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SYPHILIS: A PUBLIC HEALTH PROBLEM[1]

By Dr. THOMAS PARRAN

SURGEON GENERAL, U. S. PUBLIC HEALTH SERVICE

FROM the papers delivered here this afternoon and in the days before, one can draw a large measure of satisfaction. Individually they document, together they epitomize that advancement of science to which this association is dedicated.

There is a satisfying humility too about the manner in which you scientists have reported the results of your studies. If there is any criterion which sets the scholarship of this age above that of other ages it is that implicit recognition that what we do not know extends infinitely beyond our known horizons.

I represent that section of your work which deals with medicine and public health. I have been asked to discuss one narrow sector within the broad scope of those two sciences, the sector of syphilis. It is a field of study which on the basis of its achievements in this century occupies a satisfying place in both medicine and public health. Syphilis, as Sir William Osler has said, is a great imitator. It mocks the symptoms of other diseases; but the physician has called upon the laboratory. We can diagnose syphilis more accurately than we can diagnose most diseases. Although the treatment for syphilis is a long and complicated one, medicine is surer of a cure than it is in the case of any other similarly serious disease.

Public health administration, on the other hand, has developed techniques which have made early syphilis a clinical rarity in several nations. I would devote myself to considering the scientific progress of our field as it relates particularly to medicine and public

[1] Delivered at the meeting of the Association at Indianapolis on December 30, 1937, in the Symposium on Syphilis organized by the Section on Medical Sciences. The symposium will be published by the Association in the near future.

health, to pointing out those unsolved problems which still remain and which must be solved before it has any great right to self-satisfaction. More particularly I would dwell upon the methods which have been employed in consolidating its progress and synthesizing the findings of many earnest workers in a complicated field; and I shall compare in terms of the social sciences progress that has been made in our administrative approach to syphilis through public health and to indicate those essential social facts which must condition our policies if America is to control syphilis.

Syphilis became epidemic in Western Europe just before the year 1500. Four hundred years of earnest medical research produced able medical descriptions of the course of the disease, empirical treatment for external symptoms but nothing more basic. Syphilis, in 1900, was still listed among the incurable diseases. It could not be satisfactorily diagnosed. The organism which caused syphilis had not been discovered.

Intuitive medical statesmen, like J. Marion Sims and Sir William Osler, had warned the medical profession of the dangers of syphilis and urged the practitioner to suspect its presence. One could not reasonably expect their admonitions to be observed, for in medicine, as in every other phase of life, few men move except under the compulsion of facts.

For medical research the first decade of the twentieth century was one of those great seminal times which come only occasionally for any scientific field. Metchnikoff and Roux in 1902 infected experimental animals for the first time. In 1905, Schaudinn peered through the lens of his dark-field microscope and saw the spirochete—*Treponema pallidum*—the cause of syphilis. In 1907 Wassermann gave us the complement-fixation test. Then in 1910 Paul Ehrlich announced that he had developed in his laboratory in Frankfort-on-Main salvarsan, a subtle compound of arsenic which could be injected into the blood and would kill the spirochete but would not harm the patient. In 1921 Levadite proved the superiority of bismuth over the traditional mercury as an adjunct to early salvarsan treatment.

This was progress. We were given the tools of research. We were given the means of diagnosis. We were given a new method of treatment which revolutionized our approach to the disease.

In the years since those epic discoveries, the methodologies of modern scientific research and clinical record have brought them to a point of fine perfection. We have defined the sero-diagnostic test and made it an adaptable and accurate instrument of diagnosis. Unlike our fathers we can find syphilis when it is hidden. We can measure the effect of the treatment that we are giving.

When Paul Ehrlich announced his discovery of salvarsan, he thought that one dose would cure syphilis. That utopia was soon shattered. It took many doses to rid the patient of the spirochete. Also it required long courses of mercury or bismuth to inhibit that tendency to relapse which is characteristic of syphilis.

Syphilologists throughout the world developed empirically their own systems of treatment. Syphilology as a consequence in 1925 was a chaos of different regimens of treatment, of different dosages, of private preference for different variations of the arsenical compounds. There were many piece-meal case studies but no accurate data upon which the scientist could judge the relative efficiency of these methods.

So under the sponsorship of the U. S. Public Health Service, the heads of five of America's leading syphilis clinics, Johns Hopkins, Mayo, University of Michigan, Western Reserve and the Philadelphia General Hospital were formed into a committee known as the Cooperative Clinical Group. As a result of ten years of effort, 75,000 case records had been subjected to critical professional and statistical analysis which reveals with almost slide-rule exactness what we may expect from specific amounts and types of treatment in early and latent syphilis. The Cooperative Clinical Group system of treatment for early syphilis, announced three years ago through the U. S. Public Health Service, stands to-day as the most effective treatment yet devised and one of the most effective known for any disease so serious as syphilis.

Since Wassermann developed the complement-fixation test, various refinements of his procedure have been introduced. Flocculation tests of great sensitivity such as the Kahn, the Hinton, the Eagle and the Kline had been developed which added precision to our diagnosis of syphilis. Different tests were performed by different laboratories. Every serologist had special reasons for his preference for one or another of the tests. There are three things necessary in a diagnostic test. It must be specific; that is, it must never allege syphilis in a non-syphilitic individual. It must be sensitive; that is, it must not miss syphilis when syphilis is present. It must be adaptable; that is, it must be capable of accurate performance by trained technicians, not merely a technical trick which can be performed reliably only by its originator. Carefully controlled researches by this committee have given us a new insight into these tests. We know to-day the high sensitivity, the hundred per cent specificity and the relative degree of adaptability which the various diagnostic procedures can attain.

Other studies of the Public Health Service give us exact data concerning the number of new cases of syphilis which report for treatment each year; the number of cases constantly under treatment; the distribution of the disease by sex, color, age; the geographic variations in prevalence; the stage of the

disease when treatment is started and the length of time patients remain under care. These prevalence studies have been made in various states and cities embracing a population of more than 29,000,000.

Painstaking epidemiological work also has demonstrated the epidemic nature of syphilis. The disease spreads by a series of person to person epidemics. These epidemics can be traced, the source ascertained and infected persons brought under treatment.

The report of scientific progress in syphilology can be expanded in terms of papers that have been given at this meeting. We know much about syphilis, enough to control it, but not enough to discourage further research which will make prevention and control cheaper and more efficient. Dr. Eagle of our staff has described his approach to that uninvaded frontier of knowledge: "Just how do the arsphenamines kill the germ of syphilis?"

Did syphilis originate in America or was it an old disease in Europe which suddenly became epidemic following Columbus' discovery of America? No one has yet cultivated the *Treponema pallidum,* outside of the human or animal body. Success in this direction might point the way to immunization.

We know that the body develops a partial immunity to syphilis as a result of infection. Variations in this immunity may be responsible for variations in the results of treatment. Here again new knowledge is sorely needed.

Why does the nervous system of some persons allow the spirochete to enter, while in other patients there is a defense mechanism which protects the nervous system?

Related to immunity is the question of why pregnancy makes the course of syphilis more benign—fatal as it frequently is to the unborn child.

Why are men more likely than women to develop cardiovascular complications and what factors determine the presence or absence of these complications? The serodiagnosis of syphilis is one of the most precise of our laboratory tests, yet no one knows the why or how of these tests.

In recent years, non-specific, that is to say, heat treatment has proven to be a valuable adjunct in late syphilis. Its place in early syphilis needs further study. The present effective though long-continued treatment necessary to cure syphilis handicaps our control efforts. Urgently needed is a quicker, less painful, cheaper cure of the disease.

Knowledge is lacking also in the practical methods adapted to American conditions for the most effective control. I refer to the need for more reliable methods of determining the current incidence and distribution of the disease in the population, the most effective epidemiological procedures, the rôle of the chronic carrier versus the fresh case in promoting spread and the costs of various elements in a control program.

This is a formidable list of the deficiencies in our knowledge of syphilis. As scientific information replaces present uncertainty, our task will become easier. Fortunately, we do have now sufficient scientific knowledge to control syphilis if we *do* what we know how to do.

The essential facts which argue for syphilis control are that the disease can be diagnosed as soon as it is infectious by the dark-field microscope, later by efficient serologic tests. With one or two doses of an arsphenamine, we can render the patient promptly non-infectious, not cured; but in the arsphenamines, we have what is, in effect, a method of chemical quarantine which is as effective in preventing spread from person to person as is the physical isolation of a smallpox patient in a quarantine hospital. Our problem therefore simply resolves itself into a finding of new cases and treating them. It should be pointed out also that the causative agent of syphilis is delicate, lives only on moist surfaces, does not withstand drying. Infections occur singly from person to person by intimate contact. There are no explosive epidemics as occur in typhoid fever through pollution of a water supply. Even with our present sporadic control efforts syphilis is barely holding its own—one case on the average is giving rise to just one new case. If we can cut this infection rate in half the disease will progressively diminish.

Everywhere in science one finds a lag between the acquisition of knowledge and its practical application. This lag has been greater in syphilis than in other diseases. The taboo which until recently surrounded popular discussion has made it difficult for public health authorities in the United States to deal effectively with the problem. The lingering association of syphilis with sin has meant that it did not receive from public health officials the same sympathetic consideration that other and presumably more benign diseases have received.

We know to-day that syphilis is primarily a disease of youth; that more than half of all those whom syphilis strikes, it strikes before the age of 25; that more than a fifth are infected with the disease before they reach the age of 20, and that more than 11,000 per year are infected before the age of 15. We know that in addition to those figures for acquired infections, 60,000 babies are born in the United States every year with congenital syphilis; thus, our rate for congenital syphilis alone is twice as high per thousand of our population as Denmark's rate for syphilis of all types.

With these facts known, public opinion demands that health departments assume responsibility for dealing with syphilis. Health officers are glad to

assume it just as for other epidemic diseases. This is not radical; it merely follows the precept laid down by J. Marion Sims in his presidential address before the meeting of the American Medical Association in 1876: ". . . I would simply include syphilis in the great family of contagious or communicable diseases and make it subject to the same laws and regulations that we already possess for their management. . . ." We can prove to-day the case Sims stated on insight. We know more than Sims knew. We can face the problem of syphilis control with the same scientific objectiveness that we can face these problems of the laboratory and clinic and field investigation which I have spoken of heretofore. Syphilis has been controlled.

Sweden in 1919 was faced with the same epidemic problem of syphilis that the United States is faced with to-day. It inaugurated an effective control program which has reduced its rate to less than one twelfth of its rate in those years.

I have alluded to Denmark. If our syphilis rate was the same as that of Denmark, we would have only 26,000 cases of syphilis each year instead of 518,000 which report to doctors and the untold number which experiment on themselves with drug store compounds and the ministrations of quacks.

England has developed a system of public clinics which in a like period have reduced its syphilis rate to a fraction of what it was a decade and a half ago.

Some American states, notably Massachusetts, New York, Michigan and Wisconsin, have made a good start. It is hard for me to give you accurate trend figures on experience under American control programs. Our machinery for counting syphilis is too inadequate. The taboo which kept us from facing syphilis also kept syphilis from being accurately reported by physicians and clinics. It made doctors reluctant to suspect it and rather eager to find other plausible explanations for tenacious symptoms. Our knowledge of the extent of syphilis is gained from our intensive surveys conducted in carefully selected samples of the population. Send a corps of trained investigators into a community, as we did from 1927 to 1934. Visit in a single day every physician, every clinic, every hospital. Find out how many cases are under treatment, how many have been under treatment during the previous twelve months. You would find the real rate for syphilis going to doctors to be anywhere from two to twenty times the officially reported rates. You would find, too, how briefly these cases stay under treatment.

Before the Social Security Act was passed two years ago, it was apparent that a plan for public health would be an integral part. One does not assume risks for disability and unemployment without at the same time assuming responsibility for reducing preventable disability and unemployment. Syphilis is the preventable disease which probably takes the largest toll from our people and it must be controlled.

The Public Health Service two years ago appointed a specific advisory committee of noted local and state health officials and syphilologists to draft a program for venereal disease control which would synthesize the best features of work done here and abroad. The committee drafted recommendations for state and local venereal disease control which were essentially a summary of proven practice. They are as scientifically certain of success in the hands of capable administrators as were the diagnostic and pathological procedures in the hands of capable technicians and physicians. That committee recommended as a blueprint for a national plan:

1. There should be a trained public health staff to deal with syphilis in each state and city.

2. Minimum state laws should require reporting of cases, follow-up of delinquents, and the finding of sources of infection and contacts.

3. Premarital medical certificates, including serodiagnostic tests, should be a legal requirement.

4. Diagnostic services should be freely available to every physician without charge and should meet minimum state standards of performance.

5. Treatment facilities should be of good quality, with convenient hours and location. Wherever possible the clinic service should be a part of an existing hospital dispensary. Hospital beds should be provided for patients needing bed care.

6. The state should distribute antisyphilitic drugs to physicians for the treatment of all patients.

7. Routine serodiagnostic tests need to be used much more widely. In particular, every pregnancy, every hospital admission, every complete physical examination should include this test.

8. The informative program in modern diagnosis, treatment and control should be prosecuted vigorously, among physicians and health officers, especially through the use of trained consultants.

9. The public educational program must be persistent, intensive, and aimed especially at those individuals in the age groups in which syphilis is most frequently acquired.

Public health administration of syphilis control is thus geared to research, just as is dosage, drug and course of treatment.

These are the data upon which the current public health campaign against syphilis rests. It is clear from the record that the service has a long-time interest in scientific and practical aspects of syphilis control. It illustrates the function of the Public Health Service in dealing with all major problems of health and disease. We seek to expand the scientific knowledge upon which effective disease control must rest. We seek also

to apply to the welfare of the mass the ways and means of life-saving which have been worked out with endless patients in the research laboratory, at the bedside of the patient or in public health administration. The problems we attack must be important, that is, they must affect many people and affect them seriously. Our problems must be practical. We must not press ahead to mass application of a principle until it is proven applicable by the most rigid scientific criteria. Our whole public health program may be stated very simply. It consists of research in the laboratory, at the bedside and in the field to forge better weapons against disease. It consists of alertness along the whole front of preventive medicine to make sure that ground gained is held and gains consolidated, and a concerted attack upon the sectors where the greatest saving of human life can be made. It stems from professional colleagueship with physicians, technicians, and social scientists, unity of objective and common understanding.

Further inquiry into the sociology of our syphilis problem emphasizes its urgency as a public health problem. In the first place, so many people have it and when their disease is untreated or improperly treated, its results are so dangerous to them and so costly to the community. In the second place, it is contagious. In its untreated early stages, every person who has it is dangerous to those with whom he associates, and finally, syphilis tops the list of public health problems because we know how to be rid of it, yet are not.

Any approach to syphilis control must take into account these facts about syphilitics:

Every year 518,000 new cases appear for treatment; probably that many again experiment dangerously upon themselves with drug store nostrums or the ministrations of quacks.

Every year 598,000 advanced cases of syphilis which have never before had medical treatment report for first treatment. No serious communicable disease approaches these totals except gonorrhea.

Sixty to eighty per cent. of the patients who appear at five of the largest syphilis clinics with cardiovascular syphilis, the deadliest form of "heart disease," or neurosyphilis, have been untreated prior to the detection of these late manifestations. Half the patients with latent syphilis have had no previous knowledge of their malady.

Only one patient in five actually under treatment for early syphilis receives the minimum treatment necessary to render him non-infectious. A still fewer number receive the treatment necessary to attain a cure.

If the infected individuals actually seeking treatment remained or were kept under treatment until they had been rendered non-infectious or protected against the late manifestations of the disease, present treatment facilities would care for only 30 per cent. of the present syphilis load.

Only 20 per cent. of the physicians' syphilis patients have an income, $3,000 or more, sufficient to pay for treatment at average private rates. Twenty-eight per cent. have an income of $1,500 or less. Mind you, these figures do not include clinic patients, only private patients. This low income distribution would appear in larger proportion if we were here reviewing the syphilitic population as a whole and did not limit the analysis to those patients who already go to private physicians for treatment.

These facts which show how wide-spread the disease is, how inadequate are our facilities for treatment, our actual failure to give adequate treatment to those patients who do come for treatment and the low financial status of a larger proportion of our syphilis population are facts which must be taken into account in any objective approach to syphilis control.

These facts which we have discovered about syphilis and our population suggest considerable expenditures of public funds. It is to be pointed out in the first place that no control programs have been developed for the control of syphilis which have attained any success without such expenditures. We set up this control program, or you continue to have syphilis. If we are to control syphilis we must use those golden sinews which seem to be fundamental to any successful enterprise, public or private.

But I think we might pause to point out that money put into syphilis control may be properly classed under the heading of investment rather than expenditure. For America is spending some of its biggest medical bills to-day for the syphilis which it did not control in the years between 1910 and 1925.

Ten per cent. of our annual crop of the insane, we have said, owe their insanity to syphilis. The Bureau of the Census reported in 1933 18,700 cases of general paralysis of the insane—all due to syphilis—in our state institutions for the treatment of mental diseases. These are not all, for there are 43,000 beds for syphilitic mental and nervous patients in American hospitals, public and private. If all these are cared for at the $2.00 per day rate, which is the average for state institutions, we will show a cost of more than $31,400,000 every year for those cases of syphilis which develop nervous system complications.

Fifteen per cent. of our blindness is due to syphilis. The cost of pensions and institutional care for the blind in public institutions is conservatively estimated at more than $10,000,000 a year. There we have more than $41,000,000 for insanity and blindness.

That $41,000,000 does not include the maintenance

of the wives and children of these sufferers on relief. It does not include the cost of home care for thousands of other patients who are not in institutions. It does not include the cost of care for 160,000 patients who have cardiovascular syphilis or for the care of the wives and families of the 40,000 of them who die every year.

Some of the 60,000 babies who are born every year with congenital syphilis will die, but many of the others will grow up to be public charges.

Studies recently completed by the Public Health Service show that the loss of life expectancy for a syphilitic white male between the ages of 30 and 50 years as against the life expectancy for the general population varies from 19.5 to 16.7 per cent. And yet we all know that life insurance companies still do not include the Wassermann test as a part of the routine physical examination for life insurance.

I can not estimate the total financial cost to this country for these latter groups any more than I can estimate in objective terms the real cost of a war or a depression. But I can point out that the first $41,000,000 for institutional care is in itself a much larger figure than any one has yet suggested for the control of syphilis.

On that basis public funds for the control of syphilis become a matter of simple economy. One does not consider a balance sheet solely in terms of amounts expended but in terms of a balance between money spent and expected returns. That kind of economies is well understood by every business man when he deals with his own business.

This is the plan of our attack upon a single battle field. It is, in small, a blueprint for the national health program along a battle front. Few things which I have said about the economic gains from controlling syphilis but apply equally to other diseases—to pneumonia, to tuberculosis, to pellagra, to cancer, to malnutrition. In every field, however far our knowledge may have gone, we have that same basic problem of research. We must perfect our instruments. In every field there are techniques developed for applying that knowledge in public health administration or the means to so apply it can be perfected. This is the union of science and engineering. We are faced with the same social facts; the same shortage of hospital and other physical facilities for good health; the same lack of laboratory facilities; the same gap between individual income and the necessary minimum of medical care. It whatever field we enter we are reminded that bad health is waste. Just as it is good economics to fight syphilis, it is good economics to fight disease wherever we find it and to improve the efficiency of human beings, the greatest of our national resources.

THE SOCIAL SCIENCES AND ENGINEERING EDUCATION[1]

By Dr. WILLIAM E. WICKENDEN

PRESIDENT OF THE CASE SCHOOL OF APPLIED SCIENCE

AN engineer is a man who spends his life in solving problems. These problems assume an infinite variety of form and detail, but always end in two questions —"Will it work?" and "Will it pay?" The scale of the solution or judgment demanded in an engineering problem is never universal and seldom widely embracing. What the man in the head office wants to know is not "Will it always work?" or "Will everybody profit?" but rather "Will it work within stated limits or under particular circumstances?" and "Will it pay the investor within a given time?" For results beyond fixed limits the engineer is not held to account, but within them he is expected to be virtually right every time. Speculative inquiry and the formulation of broad judgments from loose masses of data, he willingly leaves to others, contenting himself with limited knowledge of assured character. The business world expects an engineer to know certain elemental things about the law of contracts, but when he gets into an involved situation he is expected to consult legal counsel. In much the same way, the engineer is expected as a matter of course to know certain fundamental facts and principles of economics, government, sociology and psychology, but a wise instinct prompts him to defer to expert knowledge and judgment where involved issues are concerned.

In this introductory statement, I have attempted to reduce the engineer's hard-headed philosophy to thumb-nail dimensions. Admittedly, it is not a satisfactory philosophy. It may satisfy the individual engineer in his day-to-day work, but it does not satisfy a profession increasingly proud of its achievements and aware of their revolutionary social results. Engineers do not like to think that the world has been transformed in the last century and a half merely as a by-product of their success in solving a long series of specific problems; that civilization has become what

[1] Address of the retiring vice-president and chairman of the Section on Engineering, American Association for the Advancement of Science, Indianapolis, December 29, 1937.

it is merely because Watt invented a condensing engine, Bessemer a cheap way to make steel, Goodyear a way of toughening rubber, Taylor a scientific way to shovel ore, De Forest a three-element electronic valve and so on *ad infinitum.* The idea of merely casual progress is too fatalistic. Like other men, engineers would prefer to discern some guiding principle—some thread running through the separate beads of technical achievement—which would reassure them as to the reality of progress. What is more, they would like to think that they have consciously had a part in threading the string through the beads, and should of rights have more to say in the future as to what is to be done with the beads.

Nor does the thumb-nail statement of a hard-headed philosophy satisfy the leaders of society outside of the profession. President Roosevelt, inspired by his adventures in social planning and his crusades against the power industry, admonished the educators of engineers a little over a year ago as follows:

> Events of recent years have brought into clearer perspective the social responsibility of engineering.
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> In respect to the wise use of natural resources such reports as those of the Mississippi Valley Committee, the National Resources Committee and the Great Plains Drought Area Committee have brought out the facts impressively. The enclosed report, "Little Waters," presents in miniature many of the social-engineering problems of soil and water conservation.
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> In respect of the impact of science and engineering upon human life—social and economic dislocations as well as advance in productive power—the facts are revealed with distressing clearness in public records of unemployment, bankruptcies and relief. The responsibility of scientists has been analyzed in noteworthy addresses such as, among the most recent, those presented at the Tercentenary Celebration of Harvard University, and the meetings of the British Association for the Advancement of Science.
>
> The design and construction of specific civil engineering works or of instruments for production represent only one part of the responsibility of engineering. It must also consider social processes and problems, and must cooperate in designing accommodating mechanisms to absorb the shocks of the impact of science.
>
> This raises the question whether the curricula of engineering schools are so balanced as to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility.
>
> I am calling this matter to the attention of educators of high administrative authority in the hope that it may be thoroughly explored in faculty discussions and in meetings of engineering, educational and other pertinent professional associations.

Our Secretary of Agriculture, Mr. Wallace, who is rated by observers as the most reflective thinker among the President's close advisers, has stated the problem of the engineer's capacity in matters of general social import in more direct terms:

> There is something about engineering that tends to lay emphasis on logical, cold, hard, lifeless facts. Nearly all engineers have suffered the common punishment resulting from the remorseless discipline of higher mathematics, physics and mechanics. . . . As a result, the engineer sometimes imputes a value to precise mathematical reasoning that it does not always have. There is such a thing as life, and the mathematics of life is as far beyond the calculus as the calculus is beyond arithmetic. . . . It seems to me that the emphasis of both engineering and science in the future must be shifted more and more toward the sympathetic understanding of the complexities of life, as contrasted with the simple mathematical, mechanical understanding of material production.

The engineer may be likened to a man who has lived a very busy objective life, a hard-working extravert who has at least achieved a considerable degree of success and prominence. The time seems to have come for him to broaden out. He pauses to look about him and discovers that the people who seem to be running things are different from himself. They tell him: "You may be a big butter-and-egg man, but there are a lot of things you lack. You're a sort of Philistine, you know; hard-headed and all that; short on culture; short on emotional sensitivity; short on human understanding; a good man to help pay the bills, but hardly one to run the party." The net result of his aspirations is something of an inferiority complex. If he happens to fall into wise hands, he learns that troubles with personalities, as with nerves, are not often cured; instead, they are "adjusted." Getting adjusted means taking stock of one's limitations calmly and coming to terms with them. Limitations of nature one must accept without bitterness or envy, recognizing that most men have the defects of their virtues. Limitations resulting merely from education or experience one may strive hopefully to overcome, and especially not to repeat the errors of his own rearing in the children who are to come after him.

In this spirit let us, as engineers, look at ourselves. We recognize at the start that we have certain characteristic limitations which are apparently in our natures; otherwise we might never have become engineers. We love achievement, not speculation; we crave certainties, but shun subtleties; we are at home with precise and rigorous laws, but grow ill at ease when dealing with relations of vague and uncertain character; we value objective results over the ability to sway masses of men; we find matters congenial where the possibility of rational agreement is taken for granted; with the logic of mathematics and physics we feel at home, whereas the logic of judicial sifting of conflicts in evidence seems alien to us; we

understand and practice the art of compromise where costs and values are involved, but not where political interests and emotions are in conflict. We make good administrators but poor politicians. We take command where problems in production and short-range economy are involved, but yield to others when long-time and involved questions of policy are to be dealt with. We are men who walk by sight, guided by evidence and logic; but we can not trust ourselves to walk by insight, guided by feeling and intuition. A fairly close observer has recently characterized President Roosevelt as "an artist in political emotions rather than an engineer in economic facts." I scarcely need to point out that this is a comment on us, as well as upon him.

To what degree we are what we are by nature or by nurture must be left to psychologists to decide. "Born that way" is a partial answer at best, and not a valid alibi for habits engendered by education and experience. The engineer's habit of forthrightness goes well in a world governed by the Biblical injunction, "Let your conversation be 'Yea, yea and nay, nay,'" but it tends to bar him from the world of adroit politics and suave diplomacy. His instinct for safety, his desire to be right in every case, breed a habit of deliberation, of withholding decisions until all available evidence is in, which may prove a handicap in executive positions where the risks of decision must be taken with scant deliberation. His impersonal modes of thought tempt him to think of workers and consumers as means to material ends, rather than as personalities having tastes, interests, feelings and foibles to be regarded, so that when he does venture among the subtleties of human nature he risks seeming callow and naïve.

That the characteristics sketched above can be modified by education can scarcely be denied. When the engineering graduate enters a law school, he has a difficult time adjusting himself to new forms of thought and logic. He usually overcomes the difficulty and becomes a competent lawyer, but then he is no longer an engineer. The question whether it would be possible through selection and training to alter the engineer's characteristics, especially as they affect men and society, and still leave him a competent engineer, is not so easily disposed of.

In the realm of industry two groups of problems are encountered, one to be approached through the physical sciences and the other through the social sciences. One path is well worn; the other is scarcely more than a faint trail. Through long years of association the engineer and the physical scientist have worked out a fruitful and fairly harmonious division of labor. The engineer's association with the social scientist is far less mature and effective. How far can these two go in setting up a working partnership?

The engineer's partnership with the physical scientist works because of the mutual recognition of distinctive functions. The scientist recognizes that no matter how extensive the engineer's scientific knowledge may be, science is to the latter essentially a tool, a means to certain clearly visualized ends, and not an end in itself. It is said that the engineering laboratories of one of the chief groups in the motor car industry are run by the slogan, "Where science must work, or quit!" Hard-boiled? Yes, but a perfectly proper slogan for an engineering laboratory. What is engineering but a search for the best answer to a limited problem that can be had for a limited expenditure of time and money? If all laboratories were run by that slogan, engineering progress would soon begin to slow down, then halt entirely. Engineering research pays dividends and they are soon realized, but over the decades and the centuries the richest returns come from the gratuitous and disinterested researches in pure science, from knowledge sought for its own sake alone. The goal of the engineer is tangible results, the best to be had for a given cost. To the scientist, all truth has ultimate worth and all search for truth has an inherent validity transcending any economic criteria.

As the old-time conflict between science and horse-sense in engineering has abated, engineers and researchers have worked out together a new and greatly speeded technique of progress. The old rule was first crude invention, then practical adaptation, afterward—and usually long afterward—research on fundamental principles, followed by a battle to get scientific findings accepted and adopted, and finally the perfecting of traditional practices. Men invented glass, pottery and brick at the dawn of civilization, but ceramic engineering has newly come among us. Tubal Cain, the legendary forger of metals, was of the seventh generation after Adam, but the science of metals is the work of our own generation.

The contrast between the new and the old technique of engineering progress is well exemplified in the story of the steam engine and that of radio transmission. Newcomen, you will recall, built the first workable piston engine in 1705. Nearly sixty years later Watt improved it by adding a separate condenser. Another sixty years elapsed before scientific men began to take serious interest in the engine, when Carnot published his remarkable analysis to prove that heat does work only by letting down from a higher to a lower temperature. But Carnot took no account of the heat which disappears in the process, for it was not until twenty years later that Joule established the doctrine of the conservation of energy. A science of thermodynamics scarcely existed before 1850 and its practical results were virtually nil before Rankine's attempts

to set up a systematic treatment of steam engine theory in 1859. One hundred and fifty-four years from invention to analysis, and then the battle for efficiency had only fairly begun.

How different is the story of wireless communication—Maxwell propounding on purely logical grounds his theory of electrical waves in 1865, Hertz producing the waves experimentally in 1888, Marconi applying them to wireless telegraphy in 1895, Thompson and Richardson investigating the conduction of electricity through gases in the 1880's, Elster demonstrating the principle of the two-element electronic valve in 1889, Fleming applying it to radio telegraphy in 1904, and De Forest producing the vital three-element audion valve in 1907, a series of logical steps from research to application paving the way for the swift development of perhaps the most remarkable new art in all civilized history. As the philosopher Whitehead has so sagely remarked, the most important invention of the nineteenth century was the invention of the method of invention.

Science can live without technology, but its resources are immensely enriched and its activities stimulated by the union of the two. Technology, however, can scarcely exist without the fertilizing principle of science. Technological education, dissociated from vital research in the basic sciences, quickly grows sterile and routine. The intersection of research and economic application has accordingly come to be the major focus of engineering education. Is it possible to fix a second focus at the point of conjunction of technology and social science?

The above question by its metaphorical form suggests that the social sciences have a functional and not merely a cultural relation to engineering education. "Functional" is probably as strong a word as we are justified in using. Few would suggest that social science is as yet sufficiently advanced to play an "instrumental" part, that is, to supply either tools of analysis or criteria of decision for use in solving actual engineering problems. One hesitates to bring the word "cultural" into a discussion of this character, due to its almost universal loose interpretation. Probably no field of study is inherently cultural; music, literature, history or philosophy may be either cultural or technical, according to the aim of the student and the method of the teacher. The same, I believe, may be said equally of mathematics, chemistry, mechanics or even thermodynamics. At any rate, no inherent conflict exists between the professional utility of any subject and its function as a matter of general education.

Since technology can not live without the physical sciences, the mathematician, the physicist, the chemist and increasingly the biologist are all indispensable to the engineer as team-mates, but he has found no similar bond of necessity with the several groups of social scientists. He is likely to feel unsure that the social studies are actually sciences, as yet. One prominent engineer, noting the marked capacity of social scientists for disagreement among themselves, remarked that if they were all laid end to end, they would never come to a conclusion. The evolution of a science seems to exhibit three characteristic stages. First is the stage where an emerging science is able to explain events by cause and effect after they have occurred. The second stage arrives when science is able to predict events from their antecedents, and the third stage when science is able to control these results with a fair degree of certainty. The social sciences are attempts to deal rationally with the dynamics of human nature, with an interplay of simultaneous variables so numerous as to defy mathematical analysis and with little possibility of controlled experimentation. Wholesale assumptions and simplifications are necessary to make the variables manageable for logical purposes, and the so-called laws are broad generalizations, valid in only a qualitative or at best a statistical sense. They are seldom of more help to an engineer faced with a concrete problem than are the life expectancy tables of an insurance company in the hands of a doctor with a sick patient.

When the engineer faces the question, "Will it work?" he turns to the physical sciences for his data and his tools. When he faces the question, "Will it pay?" he seldom turns to the more general of the social sciences, but rather to the very concrete science of accountancy. Any appeal to economics, sociology, political science or social psychology is likely to be at the subconscious level. This appeal is not for tools, but for premises, especially the pre-suppositions of the man higher up who sets the engineer at his problem and reserves final judgment on his recommendations. Actual team work between engineers and social scientists on this basis can scarcely be expected to develop into any such intimate collaboration as that between engineers and physical scientists. Government boards and commissions may bring the two together to an increasing degree, and more rarely the general staff of some vast industry.

What the engineer learns of social science, it seems, will be chiefly through discipleship rather than teamwork. If this is limited to one or two hurried courses in college, as is so often the case at present, relatively small gains in understanding are to be hoped for. Students who give their major effort to social science as undergraduates seldom leave college with well-organized ideas, and their professors are not always noted for special aptitude in dealing with practical situations. Teachers of engineering, I fear, take a

rather unholy pleasure over the economist who is habitually on the wrong side of the stock market or the sociologist who offers the bank his personal check to cover an over-draft, or the psychologist who is not particularly successful in the rearing of his children. Foundations for understanding can be laid in college, but the problem is primarily one of adult education.

This suggestion that the engineer must seek his education in the social sciences in his adult years is not meant to belittle but to magnify the importance of the premises of practical action which men draw from social laws and doctrines. We live in a world in the grip of ideologies—Marxist, Fascist, New Deal and conservative. The engineer is not immune, merely because his problems are limited in time and space, in scope and effect. Pass in review the major social changes of recent decades, and not one will be found to be without fairly direct influence on engineering decisions—the disappearance of a geographical frontier, the decline of agriculture and of rural living, the growing dominance of industry, the gradual stabilization of population, the numerical increase of the older age groups, the growth of cities and their centrifugal spread into semi-urban areas, the rise of taxes accompanying the rise in the proportion of wealth and income socially shared, the spread of secondary and higher education, the end of free immigration, the end of our traditional labor shortage, the rising importance of obsolescence of products or equipment, the development of research as a competitive weapon, the rising concentration of wealth in rapidly depreciating plant rather than in land of stable or rising value, the visible depletion of virgin resources, the universality of communication, the integration of industry under vast corporations, the growth of economic nationalism, and so on through the entire kaleidoscopic range. Engineers facing the risks of investment in new plant and replacements have a whole battery of new variables to reckon with.

We have more wealth than our fathers, but less security. George Washington was the richest American of his generation, as Henry Ford is reputed to be to-day. Is Ford the happier man? The Washington fortune, like most of the wealth of his day, was in land. With due allowance for changing weather, prices and skill, the productivity of land was fairly constant. It had a stable value which could be expressed like other values in terms of a single commodity such as gold with fair trustworthiness. Land could be left idle for a decade with only nominal care and suffer little or no deterioration in productive capacity or in value. As time went on and population increased, land values were certain to rise in proportion. Henry Ford's fortune, like most of to-day's wealth, is not in land but in physical plant. Except for a nominal scrap value, its worth is solely a matter of productivity. It may be worth a king's ransom to-day and nothing to-morrow. Keep it idle for five years and its value is all but destroyed. A strike may paralyze it without a moment's warning. Land has permanence, but plant is ephemeral. The values represented by imposing buildings and their equipment are mere transients, almost illusory, just the objectified forms of human ideas and ingenuity, the most changeable things we know. Over all our industrial wealth, and our personal jobs and fortunes as well, hovers the specter of obsolescence—not the slow and orderly wear and tear of daily use, but the threat of some new product of the inventor's ingenuity, some new stroke of the stylist's brush, some new whim of the consumer's caprice. Long as we may for a life of ordered security, whose passing was lately lamented by Herbert Hoover, we shall find it hard to recover.

Behind all other social issues looms the over-shadowing struggle, now world-wide, between collective security and free enterprise. Will the state, seeking to give its people security against foes without and economic hazards within, destroy the principle of individual freedom and initiative or so restrict it as to sap its vitality? As matters stand with us to-day, no one can give a confident answer to that question, but the present outlook is far from reassuring.

The social changes which are enumerated above all seem to point inevitably to an increasing degree of social control in economic processes. According to the scriptural legend, civilization began at the gates of Eden when man, whether by curse or by choice, began to eat his bread in the sweat of his brow. For 10,000 years or more man has been waging the struggle for more bread with less sweat. Out of this sweat has come one simple truth—you can have more wealth only as you produce it. There is a notion abroad that science holds some magical powers which, if properly manipulated, would work like Aladdin's lamp; that the productive machinery of society is already complete and self-operating; that discovery and invention represent doubtful gains; that thrift and investment are outmoded; that we need only to supply consumers with purchasing power from some hidden source; and that only the perversity and greed of economic royalists stand between the ordinary man and the horn of plenty. Over against these seductive illusions stands the stark fact that in the peak years of the 1920's we did not produce, nor could we produce, enough to provide for the reasonable needs of our people.

If civilization has taught us anything at all, it is that we can get gain in production only as we master the laws of nature, embody our ideas in useful forms, save our surplus to invest in tools of production and

of distribution, and set up organizations in which men can do effective work together. Discovery, invention, thrift and organized enterprise—these are the driving forces of progress tested and proved as nothing else in all man's economic experience. But driving forces are of little use unless they are restrained, guided and lubricated. The energies of steam can be made use of only when confined in a cylinder or in the blading of a turbine, held in their courses by closely fitted bearings and guides, and their way skilfully smoothed by oils and greases. By analogy, the driving forces of progress are of no avail, without social and political institutions, but these are the casing and the frame of the engine; the driving forces of progress are useless without good human relations, and these are the lubricants of industry. But the cylinders and guides, the oil pumps and grease cups never put an ounce of energy into the machinery. To keep vital the spirit of research, of invention, of thrift and of enterprise and not to allow zeal for social control to quench the fires of progress, is to-day the first concern of educator, engineer and industrialist alike.

The issues between immediate reforms and long-range goals finds no more striking examples than in the public controversy now being waged over the electric power industry. That abundant power should become our universal servant every one agrees. Steinmetz once remarked that so little power is used because it is so dear, and it is so dear because so little is used—a squirrel-cage sort of vicious circle. The administration proposes to break the vicious circle by a closer policing of the power industry. Perhaps it is true that the power industry has never quite shaken off the luxury complex of its early days, but some of us think Mr. Roosevelt is missing the main point. Policing the industry may cut a cent or two off the rate per kilowatt-hour, whereas research may some day save us the major fraction. Ignorance, represented by the fact that 100 units of energy in the coal pile end up as three units of useful light, is costing us far more than the alleged perversity and greed or the misdirected financial magic of the utility magnates.

In this connection it is pertinent to recall the visit of a committee of the British Parliament to Faraday's laboratory at the Royal Institution, to view his discoveries in electromagnetism. One practical politician, on being shown an instrument of no apparent use, asked contemptuously, "Humph! Of what possible value is a thing like that?" "Some day," Faraday replied, "you may be able to tax it." What prophetic words! Last year the electrical industry which grew from Faraday's seemingly useless toys is said to have paid more than a quarter of a billion dollars in taxes in the United States alone, a sum many times greater than the total cost of winning for society our entire knowledge of electrical science. Taxes, as we know, represent only a minor fraction of the wealth on which they are levied. Who can guess the sum of the wealth created by Faraday's life and work? Ignorance remains, as it always has been, the chief barrier between the common man and the more abundant life, while research probably yields the greatest return, dollar for dollar, of all our forms of expenditure.

The country stands in dire need of between six and ten millions of additional jobs. If our millions of idle are ever to be employed, it will be in jobs not yet created, in serving industries not yet organized, in applying scientific truth not yet discovered, in operating machinery not yet invented, in making products not yet developed and in supplying needs of which the public are as yet scarcely aware. This is the road that leads to the more abundant life.

Mr. Roosevelt is probably justified in his doubts concerning the ability of our present forms of engineering education "to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility." The fault, I believe, is not so much with what is taught or left untaught in college, as with a scheme of education which ends too often at college doors. Foundations of social understanding should be laid in college, and are being laid far more widely and effectively than the President probably realized, but the ability to consider social processes and problems in the design and construction of engineering works or of instruments of production and to cooperate in designing mechanisms to absorb the shocks of the impact of science is the proper objective of a lifetime of education.

The work of the engineering colleges has been an active subject of discussion in professional circles these last fifteen years, with splendid gains on both sides. The profession has advanced its standards both in order and in quality and has quickened its touch on the lives of young men. The schools have moved steadily toward a type of training which is both more liberal and more fundamental, with greatly increased opportunities for advanced specialization after graduation. The lines have been mapped for years of further progress in our leading colleges. May I suggest, in conclusion, that this fine zeal on the part of the profession now be transferred for a time to a new area, that of further education for the young engineer in the first ten years of his active career? It is here, I believe, that the battle of social-mindedness is won or lost. The Engineers' Council for Professional Development, representing jointly seven national engineering bodies, has taken this period of the engineer's

education as one of its principal concerns. The council is an agency for stimulation and coordination and not an operating body. What it can accomplish must be done principally through existing professional and educational institutions. What the national engineering societies can accomplish will be largely through their local chapters and sections. What the colleges can contribute to further education after graduation will be largely on a local basis. With the Engineers' Council for Professional Development now organized to give impetus and guidance on a national scale, next steps in progress seem to lie in the establishment of effective local joint councils or committees on professional education and development.

In the goals for this period of education, a mature understanding of social and economic processes should have a prominent place. It should be our concern not only to make the engineer competent to design and build with an understanding of social consequences, and to do his part to develop shock-absorbing mechanisms to ease the impact of technological change, but also to raise his voice in defense of sound economic and social policies which have stood the fire of experience.

OBITUARY

THE SCIENTIFIC WORK OF VERNON KELLOGG

WHEN one reviews the scientific work of Kellogg he finds the record of a keen, active, versatile mind, reflecting immediately the influence of his surroundings, and disclosing an eagerness to state his findings and to share his impressions. The thought leaps forth and must find expression. There is little of long and labored investigations builded into finished works, but more often a flashing exposition of some definite topic. There is not lacking, however, sustained interest, but it manifests itself over long periods of time and not in a continuous and exclusive application. Thus his first paper on Mallophaga appeared in 1890 and up until 1915, thirty-nine others on this subject followed. Sometimes several years would pass without any published work on the biting lice and then a group of as many as five articles would be written in one year.

Similarly, insect taxonomy continued to interest him and in a decade he wrote twelve papers. A like number of works on insect morphology in the same period were published.

The strong influence of his surroundings is early manifest. Accordingly, in his first year of investigation, papers upon Mallophaga, birds, preservative fluids for museum specimens and the action of a Pasteur filter were produced. In each case contact with another investigator was responsible for his interest in the subject reported upon. In the years immediately following, papers upon economic entomology predominate because of the practical work upon the chinch bug begun by Dr. F. H. Snow.

Back of his practical studies there was, in the mind of Kellogg, a growing concern for the biological principles manifest in comparative insect morphology, taxonomy and phylogeny. Association with Comstock and Jordan did much to strengthen these interests, and papers dealing with applied entomology became few. In the second decade of his work the extension of knowledge through the writing of text-books claimed much of his interest, and rarely did a year pass without the appearance of some book from his pen. Apparently this was somewhat of a diversion for an easy writer because it did not at all interrupt the steady flow of manuscripts upon a wide range of investigations. Thus in 1904 in addition to a book on "Insect Anatomy" there were papers upon such diverse subjects as parthenogenesis, amitosis, bionomics, regeneration, experimental variation, sex-characters, Mallophaga and South Sea travel. The active, discursive nature of his mind is indicated by the fact that articles characterized as Reviews, Notes and Biographies, covering a wide range of subjects, are most numerous. The breadth of his interest is best shown by the number of papers upon each subject during his first twenty-five years of study when his mind was not distracted by administrative matters. These may be summarized as follows: Mallophaga, 39; reviews and biographies, 28; books, 18; applied entomology, 18; general biological topics, 15; insect morphology, 12; insect taxonomy, 12; evolution, 10; insect development, 8; ornithology, 6; silkworms, 6; insect notes, 5; travel, 3; heredity, 3; eugenics, 3; education, 3; parasitology, 3; Lepidoptera, 3; spiders, 2; insect physiology, 2; bionomics, 2; technique, 2; regeneration, 2; insect behavior, 2; arthropods, 2; animal psychology, 1; insect cytology, 1; distribution, 1; echinoderms, 1; parthenogenesis, 1; metagenesis, 1; Coleoptera, 1. These classes are not always mutually exclusive, but taken in this way reveal the general trend of Kellogg's thinking. The first eight topics are presented in 152 papers out of a total of 209, and show the concentration of his interest upon them. Probably his largest contribution to new knowledge came from his studies upon the Mallophaga. These were undertaken, in the beginning, because Kellogg considered the insects valuable as an index of the relations between bird species, but later the studies were continued on account of his preoccupation with the phylogeny of the Mallophaga themselves. The numerous papers that continued to

appear were almost entirely filled with detailed descriptions of new species from different avian and mammalian hosts. Only occasionally are theoretical conclusions introduced.

It is obvious, however, that because of his concern for the significance of biology in human affairs, his chief service consisted in the dissemination of knowledge and in its interpretation and application. Some phases of such contributions arose directly from his investigations, but others, and his most noteworthy, resulted from the carrying over into educational, administrative and philanthropic affairs the view-point and methods which characterized his investigations. In these matters above all he was a distinguished and worthy exponent of American biology.

Kellogg's career as an investigator, extending over a quarter of a century, practically ceased when he became involved in war-time activities. From these he did not return to his post at Leland Stanford but established himself in Washington. His writings continued, but they took the form of direct approaches to the general public as books, newspaper articles and magazine articles. Creditable as were his own studies, he will undoubtedly be longest remembered as one of our few good interpreters of science. In his later years his writings were almost entirely of this nature.

His approach to a subject was always honest and straightforward. He had the courage of his convictions and did not hesitate to take a position because it was unpopular. He was an inspiring and helpful teacher with his own students and greatly extended his influence by his writings, which were clear and forceful.

C. E. McClung

UNIVERSITY OF PENNSYLVANIA

SCIENTIFIC EVENTS

PROGRAM OF THE CAMBRIDGE MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

LORD RAYLEIGH was installed on January 7 as president of the British Association for the Advancement of Science for 1938, in succession to Sir Edward Poulton at a conference held at Birkbeck College. The main outlines of the program for this year's Cambridge meeting of the association were discussed by the organizing committees of the various sections at this meeting.

The London *Times* gives the following outline of the proceedings of the conference:

Professor W. W. Watts, who presided at the outset, explained that Sir Edward Poulton could not be present because he had had a fall a fortnight ago and his doctor pronounced him not yet fit to make the journey. Professor Watts proposed a vote of thanks to the retiring president for his services and welcomed Sir Edward Poulton's successor. The association, he said, had not often had father and son in the presidential chair; he thought there was only one previous instance. There had been a case of a grandson following his grandfather, and certainly one where a great-great-grandfather was followed by his great-great-grandson, after a decent interval of 70 years. They also welcomed Lord Rayleigh on account of his marvelous scientific research work and his successful association with other scientific societies and their organization.

Lord Rayleigh, from the chair, said he had received a telegram from Sir James Jeans (who is presiding over the Indian Science Congress at Calcutta) conveying best wishes to himself from the British Association delegates at the congress. The following reply had been sent: "On behalf of British Association, warmest greetings and wishes for the success of congress. Look forward with pleasure to working with colleagues on their return."

Lord Rayleigh said he had jotted down a few headings, lying quite outside his own real knowledge, as suggestions for possible discussion in the various sections at the Cambridge meeting. In Section A he thought they might usefully have something about the modern magnetic alloys. There was a good deal of modern knowledge of them from the x-ray direction, and he thought Professor Bragg would be willing to lead in a discussion. He had been interested at various times in the brilliant colors of insects, such as, for instance, the amorpha butterflies and the brilliantly iridescent beetles. He had never seen any discussion of Nature's object in creating those brilliant color effects. Were they associated with the sexual instinct of insects, and were we to attribute esthetic perception to insects? A subject touching on both chemistry and biology was the processes by which rare elements were segregated in the earth. It seemed to him that some discussion of those processes, which seemed to be very marvelous examples of selective crystallization, and comparison of them with the artificial processes of the laboratory might afford the basis of an interesting discussion.

F. P. White, as local secretary of the association at Cambridge, reported that Emmanuel College had offered to accommodate sectional officers to the number of fifty, but men only. It would mean separation from wives; and such women officers as there were would have to have other hospitality found for them.

There will be no separate meetings of Section I (physiology) at the Cambridge meeting on account of the coincidence of dates with the International Physiological Congress in Switzerland.

SYMPOSIUM ON MATHEMATICS AT THE UNIVERSITY OF NOTRE DAME

A SYMPOSIUM on the Algebra of Geometry and Related Subjects was held at the University of Notre Dame, Indiana, on February 11 and 12.

Dr. Edward V. Huntington, of Harvard University,

gave a general lecture on "The Duplicity of Logic" on the evening of the first day's session. Dr. Marshall H. Stone, professor of mathematics at Harvard University, spoke on "Boolean Algebra," and Dr. John von Neumann, of the Institute for Advanced Study at Princeton, on "Continuous Geometry." Dr. Garrett Birkhoff, of Harvard University, read a paper on "Partially-Ordered Function Spaces." He has collaborated with Dr. von Neumann in writings on several mathematical subjects. Dr. Oystein Ore, of Yale University, discussed "Structures and Their Application." Participants from the University of Chicago were Dr. A. Adrian Albert, professor of mathematics, and Dr. J. K. Senior, professor of chemistry, who discussed certain applications of algebra to chemistry.

The University of Notre Dame was represented by Dr. Karl Menger, associate professor of mathematics, formerly professor of mathematics at the University of Vienna and a visiting professor at Harvard University and the Rice Institute, and Dr. Emil Artin, associate professor of mathematics, who was formerly professor of mathematics at the University of Hamburg and is known for his work on the theory of numbers. He gave the concluding address on "Geometric Aspects of an Algebraic Subject." Dr. Arthur N. Milgram, also of Notre Dame, presented a paper on "A Theorem on the Algebra of Geometry."

In addition to those mathematicians who presented formal papers, a number of foreign mathematicians attended the sessions. Among these were the Canon Lemâitre, who arrived recently from Louvain, Belgium, to assume his post as visiting professor at Notre Dame during the second semester.

THE WILLIAM LOWELL PUTNAM MATHEMATICAL COMPETITION

THE Mathematical Association of America, an organization of nearly two thousand teachers of college mathematics, announces an intercollegiate mathematical competition to be held for a period of at least three years beginning with the spring of 1938. It is designed to stimulate a healthful rivalry in the undergraduate work of mathematical departments in colleges and universities of the United States and Canada. This is made possible by the trustees of the William Lowell Putnam Intercollegiate Memorial Fund, left by Mrs. Putnam in memory of her husband, a member of the Harvard class of 1882. The competition is open only to undergraduates who have not received a degree. A full announcement is being made through *The American Mathematical Monthly* and by letters to the heads of the departments of mathematics. The first examination will be held on Saturday, April 16.

The examinations will be constructed so as to test not only technical competence but also originality. The groundwork of knowledge required for the examination is such as would usually be met by two years in the calculus, a half year's work each in higher algebra and differential equations and a year's work in analytic geometry.

Any college or university may enter individual contestants or a team of three persons; the largest awards go to the latter. There will be awarded to the departments of mathematics of the institutions which have the first three winning teams the sums of $500, $300, $200 in the order of their rank. There will be awarded to each member of the three winning teams and to each of the first five contestants a suitable medal indicating his success in the competition and, in addition, to each member of the three winning teams a prize of fifty dollars, thirty dollars or twenty dollars, according to the rank of his team, and to each of the first five contestants a prize of fifty dollars.

For further encouragement of the competition by the trustees of the fund, there will be awarded at Harvard University[1] an annual $1,000 William Lowell Putnam Prize Scholarship to one of the first five contestants, this scholarship to be available for one of the two following academic years, at the option of the recipient.

The records will be available to all institutions interested, and the association is sponsoring this plan in the hope that other institutions may find it possible to offer scholarships to winners in the contest.

GRANTS FOR RESEARCH OF THE GEOLOGICAL SOCIETY OF AMERICA

RECENT grants made by the Geological Society of America in furtherance of research are as follows:

$10,300 to Francis P. Shepard, of the University of Illinois, in cooperation with the Scripps Institution of the University of California at La Jolla, California, for the investigation of the physiography, current dynamics and sedimentation in selected areas of the sea floor off the California coast.

$1,000 to W. F. Prouty, Chapel Hill, North Carolina, for magnetometer study of the origin of the "Carolina bays" of the Atlantic Coastal Plain suspected by some geologists to have been due to a shower of meteors.

$254 to John T. Lonsdale, Ames, Iowa, for a petrographic study of igneous rocks from the Terlingua district, Texas.

$572 to George M. Schwartz, Minneapolis, Minnesota, and A. E. Sandberg, Cincinnati, Ohio, analyses of several phases of three Keweenawan sills closely related to the Duluth gabbro.

$1,000 to Arthur C. Veatch, New York City, for continuation of his investigation, in cooperation with the United States Coast and Geodetic Survey, of submarine

[1] Or at Radcliffe College, in the case of a woman.

topography off the Atlantic coast, beyond the 1,000-fathom line.

$6,300 to Alfred C. Lane, Cambridge, Massachusetts, for continuing determination of ages of rock specimens by the helium method.

$750 to G. Marshall Kay, New York City, for a study of the structure of northeastern Ontario with view to correlating the peneplane of central Ontario and revising paleogeographic maps.

$500 to Frank M. Swartz, State College, Pennsylvania, study of ostracoda from Lower Devonian-Upper Silurian beds, chiefly from southeastern New York and New Jersey.

$405 to Raymond E. Peck, Columbia, Missouri, covering collecting and studying oogonia and ostracoda from late Cretaceous and early Tertiary beds of Wyoming, eastern Idaho and Montana.

$1,200 to Robert T. Hill, Dallas, Texas, to continue investigation of the history of geological exploration of the southwest.

$2,000 to Frank F. Grout, Minneapolis, Minnesota, contribution to the support of the University of Minnesota Laboratory for Rock Analysis, in the service of petrologic science.

$300 to William C. Putnam, Los Angeles, California, completion of physiographic study of the Ventura region, California.

$1,200 to Roger Revelle, Scripps Institution of Oceanography, of the University of California at La Jolla, California, systematic study of sediments from the floor of the Pacific.

$100 to Horace R. Blank, Waco, Texas, for analyses supporting investigation of the occurrence and nature of an unusual feldspathoid dike rock encountered in one of the many tunnels in the Manhattan schist under New York City.

$340 to Nelson H. Darton, Washington, D. C., to continue an investigation of overlap relations of Tertiary and Cretaceous formations in eastern Maryland and Virginia.

PHYSICS IN THE AUTOMOTIVE INDUSTRY

THE many applications of the science of physics in the automotive industry will be the subject of a symposium to be held under the auspices of the American Institute of Physics at the University of Michigan, Ann Arbor, on March 14 and 15. The meeting will be open to physicists and to all other scientific or technical men interested. Only a preliminary announcement can be made at this time of the extensive program of papers which will be presented. Any one interested may receive a final announcement by mail on request to the office of the institute in New York.

The tentative list of speakers includes:

- Lyman J. Briggs, director, National Bureau of Standards.
- K. T. Keller, president, Chrysler Corporation.
- Charles F. Kettering, vice-president of General Motors Corporation and director of General Motors Research Laboratory.
- M. Muskat, Gulf Research and Development Corporation.
- J. S. Thomas, president, the Chrysler School of Engineering.
- E. J. Martin, the General Motors Research Laboratory.
- Paul Huber, Proving Grounds, the General Motors Corporation.
- Lloyd Withrow and Gerald Rassweiler, the General Motors Research Laboratory.
- F. A. Firestone, department of physics, the University of Michigan, and others.

The subjects to be discussed will include the general relationship of physics to the automotive industry, scientific training and a number of technical topics, such as seeing and lighting in connection with highway hazards, lubrication, noise measurement and other phases of automotive acoustics, physical methods of studying engine combustion, instruments, spectrochemical analysis, theory of materials and others. Many of the papers presented will be published later in the *Journal of Applied Physics*.

The department of physics at the university will act in the capacity of host. Excellent and economical facilities will be available for lodging and meals. There will be a dinner for all attending the symposium on the evening of March 14. Dr. Charles F. Kettering will deliver the principal address on the subject "Scientific Training and its Relation to Industrial Problems." An inspection tour of the laboratory is being arranged showing the facilities for research and instruction with particular emphasis on current or completed researches of industrial importance. Ann Arbor is situated about forty miles west of Detroit, the principal railroad being the Michigan Central (New York Central Lines).

THE AMERICAN PHILOSOPHICAL SOCIETY

A JOINT meeting of the American Philosophical Society, Philadelphia, with representatives of organizations and institutions concerned with the publication of research will be held on February 18 and 19.

On Friday morning and afternoon round-table conferences will be held, over which Dr. Edwin G. Conklin, vice-president of the society, will preside. Jacob R. Schramm, editor-in-chief of *Biological Abstracts,* professor of botany and director of the department of botany at the University of Pennsylvania, and Robert C. Binkley, chairman of the Joint Committee on Materials for Research of the American Council of Learned Societies and Social Science Research Council, will open the discussion of the following subjects: "Possible Economies in the Conventional Methods of Publishing" and "Auxiliary Methods of Publishing."

On Friday evening addresses will be made by Dumas Malone, director of the Harvard University Press, on "The Scholar and the Public," and by Donald P. Bean, director of the University of Chicago Press, on "The Riddle in Research." The addresses will be followed by a reception.

On Saturday morning, February 19, there will be an executive session for members of the society, with Roland S. Morris, president, presiding. At 10:30 an open session will be held to discuss the publication program of the American Philosophical Society and proposals for its improvement as follows:

Class I—Mathematical and Physical Sciences: Hugh S. Taylor, professor of physical chemistry and chairman of the department of chemistry, Princeton University.

Class II—Geological and Biological Sciences: Albert F. Blakeslee, director of the department of genetics, Carnegie Institution of Washington, Cold Spring Harbor.

Class III—Social Sciences: Ernest M. Patterson, professor of economics, University of Pennsylvania.

Class IV—Humanities: Waldo G. Leland, permanent secretary, American Council of Learned Societies.

In the program announcing the meeting, the problems to be considered are stated as follows:

The problem of scholarly publication is in large part a financial one. A careful study made by the director of the University of Chicago Press some years ago brought out the fact that we incur an annual national deficit of $1,700,000 in publishing works that are hereafter to be of value in the various fields of learning. Of this deficit, approximately $500,000 is incurred on account of the publication of scientific and learned journals, and $1,200,000 on account of the publication of books. . . .

In the conference of February 18 it is proposed to discuss the possibilities of reducing the cost of publication. It is suggested that the discussion shall first deal with possibilities of reducing the cost of manufacturing periodicals and books by conventional printing-press methods which involve type setting. In the second part of the conference it is suggested that the discussion should be devoted to possible reductions of cost by the use of auxiliary methods, mostly photographic, such as the photo-litho offset process, the use of the ditto or hectograph, the use of the microfilm. There will be an exhibit of apparatus used in these newer methods of publishing.

SCIENTIFIC NOTES AND NEWS

DR. ROSS G. HARRISON, Sterling professor of biology at Yale University, has been elected chairman of the National Research Council, to succeed Dr. Ludvig Hektoen, who has become executive director of the National Advisory Cancer Council of the Public Health Service. Dr. Harrison takes office at once.

DR. LIBERTY HYDE BAILEY, emeritus professor of agriculture and formerly dean of the New York State College of Agriculture, was given recently the ruby award of Epsilon Sigma Phi, national honorary extension fraternity. This award is the highest offered by the fraternity and was given to Dr. Bailey for his achievements as one of the "leading rural statesmen of the world."

RICHARD WELLINGTON, professor of pomology and chief in research at the Experiment Station, Geneva, N. Y., has been awarded a gold medal by the Massachusetts Horticultural Society for his work in fruit breeding.

THE Hillebrand Prize of the Chemical Society of Washington (the Washington Section of the American Chemical Society) for 1937 has been awarded to Dr. Sterling Brown Hendricks, of the Fertilizer Research Laboratories of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, for his contributions on "The Relation of Crystal Optics to Crystal Structure" and "The Determinations of Molecular Structures by X-ray and Electron Diffraction."

EDWARD W. KELLOGG, of the Radio Corporation of America, formerly a member of the department of electrical engineering of the University of Missouri, was awarded a medal for "outstanding achievement in motion picture technology" at the recent meeting of the Society of Motion Picture Engineers of New York City.

PROFESSOR I. M. KOLTHOFF, of the School of Chemistry of the University of Minnesota, has been elected to foreign membership in the Royal Society of Letters and Sciences of Bohemia in consideration of his services to science.

THE Faraday Medal of the British Institution of Electrical Engineers has been awarded to Sir John Snell, chairman of the Electricity Commission. The medal is awarded annually for "notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence or membership of the institution."

HONORARY doctorates have been conferred by the University of Basel on Dr. Paul Karrer, professor of chemistry at the university, and on Dr. Leopold Ruzička, professor of chemistry at the Zurich Polyclinic.

NEWLY elected officers of the Sullivant Moss Society are: Dr. G. E. Nichols, *president;* Dr. H. S. Conard, *vice-president,* and Dr. R. A. Studhalter, reelected *secretary treasurer.* Dr. O. E. Jennings has resigned

as editor-in-chief of *The Bryologist.* He has been succeeded by W. C. Steere.

Dr. B. A. Keen, assistant director of the Rothamsted Experimental Station, Harpenden, has been elected president of the Royal Meteorological Society, London.

Dr. Percy Hodge, professor of physics and head of the department at the Stevens Institute of Technology, has been appointed professor emeritus. Dr. Hodge has been a member of the faculty since 1911.

Professor C. E. Gordon, head of the division of physical and biological sciences at the Massachusetts State College, has been appointed professor of geology and mineralogy. He will be at the head of the newly established department of geology and mineralogy. Dr. Gordon, who has been in charge of zoology and geology since 1910, has, at his request, been relieved from the further direction of the work in zoology, which has been combined with entomology as a department under the direction of Dr. C. P. Alexander.

At Vassar College Dr. Lyle H. Lanier, of Vanderbilt University, has been appointed professor of psychology to succeed Dr. Margaret Floy Washburn, professor emeritus, who retired in June. Dr. Boris G. Karpov, of the University of Minnesota, has been appointed instructor in astronomy. Dr. Elizabeth J. Magers has been promoted to an associate professorship of physiology, and Dr. Elizabeth Butler and Dr. Madelene Pierce to assistant professorships of zoology.

Dr. Gerald M. Cover, of the National Steel Corporation at Steubenville, Ohio, has been appointed associate professor of metallurgy at the Case School of Applied Science, Cleveland.

Dr. Eugene Feenberg, of the Institute for Advanced Study, Princeton, has been appointed a member of the faculty of the department of physics at the Washington Square College of New York University.

Dr. William H. Brown, formerly director of the Bureau of Science at Manila, has arrived in Baltimore to take up his work as lecturer in botany at the Johns Hopkins University.

Dr. H. L. A. Tarr, of the Rothamsted Experimental Station, has been appointed to the Sir William Dunn Institute of Pathology, University of Oxford, where he will carry out research on the chemistry of the bacteria responsible for certain human diseases.

Dr. N. H. Darton, long geologist in the U. S. Geological Survey, has been elected an honorary member of the American Association of Petroleum Geologists. Since his retirement from the survey at the end of 1936 Dr. Darton has continued field work in the Atlantic Coastal Plain region.

Dr. Allen Kane, medical superintendent of the Municipal Sanatorium at Otisville, N. Y., has been appointed director of the newly created Division of Tuberculosis in the Department of Hospitals, New York City.

Dr. Thorne Deuel has been appointed chief of the Illinois State Museum to succeed Arthur S. Coggeshall, who resigned recently to become director of the Santa Barbara Museum of Natural History.

Dr. Marvin L. Fair, professor of transportation and public utilities at Temple University, Philadelphia, has leave of absence to enable him to become research director for a survey under the Federal Communications Commission of radio and safety requirements on the great lakes and inland waters. He took active charge as research director on February 1.

Richard E. Scammon, professor and dean of the graduate faculty of the Medical School, University of Minnesota, has been appointed chairman of a Minnesota drainage basin committee which will work on a national plan for the prevention and control of floods and the development of a water and soil conservation program.

Professor C. Regaud has retired from his position as director of the Radium Institute of Paris and has been succeeded by Dr. Antoine Lacassagne.

The Archbishop of York (Dr. William Temple), has been elected president of the British Society for the Protection of Science and Learning, formerly the Academic Assistance Council, in succession to the late Lord Rutherford.

Dr. Harlan T. Stetson, of the Massachusetts Institute of Technology, will deliver the seventh Arthur lecture under the auspices of the Smithsonian Institution at the U. S. National Museum on February 24. His subject will be "The Sun and the Atmosphere."

Dr. H. H. Whetzel, professor of plant pathology at Cornell University, delivered a series of lectures at the Iowa State College from January 31 to February 3. His subject was "The Teaching of Plant Sciences and Recent Advances in Plant Pathology Research."

The Illinois State Museum recently initiated a series of popular science lectures for February and March. On February 3, Dr. Carey Croneis, associate professor of geology at the University of Chicago, spoke on the origin and development of life on the earth. On February 25, Professor Fay-Cooper Cole, chairman of the department of anthropology of the University of Chicago, will speak on the Philippines. Dr. M. M. Leighton, of the State Geological Survey, will discuss the coal and oil resources of Illinois on March 16.

THE twenty-second annual meeting of the Pacific Division, American Association for the Advancement of Science and its affiliated societies, will be held at San Diego, Calif., from June 20 to 25. Seventeen societies propose to participate in the meeting by the organization of sessions for the presentation of papers by members and guests. A preliminary announcement descriptive of the meeting will be mailed to members of the division during the latter part of March. The titles of contributed papers should be sent to the secretaries or program chairmen of the participating societies not later than April 20.

THE fourth International Congress for the Unity of Science will be held at Girton College, Cambridge, England, from July 14 to 19. The subject of the conference will be "Scientific Language."

THE eleventh International Congress of the History of Medicine will meet from September 3 to 11 in Jugoslavia, at Zagreb, Belgrade, Sarajevo and Ragusa. Subjects for discussion include botany and zoology in medicine; minerals in medicine; medicine in poetry; mysticism and magic in medicine; psychological disorders and psychotherapy in medicine. Dr. Lujo Thaller is president of the congress, and the secretary-general is Dr. Vladimir Bazala. Communications should be addressed to Dr. Bazala, Vlaska ulica 95, Zagreb, Jugoslavia.

THE University of Rochester chapter of Sigma Xi will hold its seventh annual Sigma Xi day on February 22 under the presidency of Dr. Benjamin H. Willier. Plans are being made for lecture-demonstrations which will be of interest to the general public as well as to professional men of science. As in previous years, a lecture-demonstration will be held for science students in local high schools. This year Dr. Lee A. DuBridge, Harris professor of physics at the university, will lecture on the nature and uses of electricity. The evening lecture will be given by Dr. Karl S. Lashley, of the Laboratory of Physiological Psychology, Harvard University. All meetings will be free to the public.

THE annual meeting of the Wildlife Society was held at Baltimore during the week beginning February 13, when the council met at the Lord Baltimore Hotel at 2 P. M. on February 13; the regular meeting was opened at 7:30 P. M. on February 14 at the Alcazar Hotel, and a social gathering of the society was held at the hotel on February 15.

A SHORT course on broadcast engineering, said to be the first of its kind, was given from February 7 to 18 by the department of electrical engineering of the Ohio State University. Its purpose, as outlined by Professor W. L. Everitt, conference director, is "to bring together leaders in the industry and practicing engineers from all parts of the United States and Canada in a discussion of some of the most important technical problems." A limited enrolment was announced "so that all attending may benefit from the round-table discussion." Taking up three subjects a day, the program provided for one hour of formal lecture followed by an hour's discussion. Speakers included Harold H. Beverage, chief research engineer, R.C.A. Communications, Inc.; George M. Nixon, development engineer, National Broadcasting Company; George H. Brown, of Godley and Brown, consulting radio engineers; William H. Doherty, of the radio development department of the Bell Telephone Laboratories; Harold L. Oleson, of the Weston Electrical Instrument Corporation; John F. Byrne, engineer for the Collins Radio Company, formerly of the Ohio State University; John H. Dellinger, chief of the radio section, National Bureau of Standards; Herbert M. Hucke, chief communications engineer for the United Airlines Transport Corporation; Peter C. Sandretto, United Airlines communication engineer; Arthur E. Thiessen, commercial engineering manager for General Radio Company, and Professor Everitt, of the Ohio State University.

THE Harold H. Brittingham Memorial Library was dedicated at the City Hospital, Cleveland, Ohio, on the evening of January 25. Dr. Howard T. Karsner, professor of pathology at Western Reserve University, and Fred W. Ramsey, director of public health and welfare, gave the principal addresses. About 200 people were present. Dr. Brittingham had been a member of the medical staff of City Hospital since 1923. He became secretary of the staff and also a member of the executive committee in 1935 and had been assistant head of the department of medicine since July, 1935. Shortly after his death in January, 1937, a corporation was formed to establish a medical library and donations were received amounting to nearly $7,000. A membership plan to continue support is in operation. In pursuance of the action of the council the city has agreed to furnish suitable library space and a librarian.

THE expenditure of $4,000,000 for research in order to find new uses for farm products is authorized in the conference committee report on the A.A.A. act of 1938. It is proposed to establish four special laboratories in the principal farming regions of the United States. It is planned "to conduct researches into and to develop new scientific, chemical and technical uses and new and extended markets and outlets for farm commodities and products and by-products thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or sea-

sonal surpluses, and their products and by-products." Acceptance and utilization of donations and volunteer services from non-official sources is also authorized.

A GIFT in excess of $100,000 has been made to Northwestern University for the establishment of a Milton S. Florsheim Heart Institute to conduct research on diseases of the heart. The gift was made by Mrs. Florsheim in memory of her husband, the late Milton S. Florsheim, founder and president of the Florsheim Shoe Company. The agreement with the university provides that the income of the gift shall be expended "in the employment of technical and research personnel for studies in heart diseases, in the purchase of equipment and supplies for such studies, and in the publication of the results thereof."

FARM properties, with equipment and stock, valued at approximately $1,000,000, have been given by Charles E. McManus, poultry dealer, to the University of Maryland for experimental work in agriculture. It consists of 276 acres known as the Spring Hills Farms, about eighteen miles north of Baltimore. The only condition made by Mr. McManus is that the property shall be utilized solely for the benefit of agriculture.

THE Carnegie Corporation of New York has granted to the Rochester Athenaeum and Mechanics Institute the sum of $15,000 for further investigation and development of the anecdotal record in relation to the problems on mental hygiene.

DR. GEORGE D. FULLER, professor emeritus of plant ecology at the University of Chicago, has been authorized to establish in the Illinois State Museum at Springfield a herbarium of about five hundred of the more common plants of Illinois.

THE Maryland State Conservation Commission plans to build a new dormitory at the Chesapeake Biological Laboratory at Solomon's Island at a cost of $25,000. Plans for the building have been completed and the commission is prepared to purchase land on which it will be built. The legislature appropriated funds for the building in 1937.

THE Iowa State College Agricultural Foundation has been established through an anonymous gift to the Iowa State College. The foundation has received a gift of nine farms in various counties of Iowa, on which various aspects of farm operation will be intensively studied, as well as funds for the work. The articles of incorporation provide for: (1) developing practical, economical and profitable methods of cultivation and management of ordinary or family-sized farms; (2) determining the crops best adapted and most profitable to be grown in the various sections of Iowa; (3) determining the types, breeds and classes of live stock to be produced and used on the farms of the various sections of the state, including care, breeding and feeding; (4) conserving and building up the soil and natural resources of such farms; (5) developing the social, educational and religious environment of those engaged in agriculture in the localities where such farms may be located; (6) improving the conditions of social and family life; (7) publishing and disseminating the information and the results obtained. The board of trustees of the foundation consists of President Charles E. Friley; George W. Godfrey, secretary of the board; Dean H. H. Kildee; Extension Director R. K. Bliss, all of Iowa State College; and Deane W. Trick, of Des Moines; C. R. Musser, of Muscatine, and J. H. Anderson, of Thompson.

DISCUSSION

THE LOG OF PALMER'S DISCOVERY OF ANTARCTICA[1]

ANTARCTICA, fifth in size among the seven continents, both Australia and Europe being smaller, was discovered on Saturday, November 18, 1820, by Captain Nathaniel Brown Palmer, of Stonington, Conn. The hour was 4 A.M.

This is proved by the logbook of the sloop *Hero*, now in the Library of Congress, and from 1820 to 1927 continuously in the possession of its author, his brother (Captain A. S. Palmer), his niece (Mrs. Richard Fanning Loper) and his great-nephew (Mr. A. P. Loper), all residents of Stonington.

Acknowledged since 1821 throughout the world, the fact of Captain Palmer's discovery is now known to rest upon first-hand evidence—the logbook itself—rather than upon secondary sources.

Recognition of this great achievement by explorers, by governments and by scientific associations includes those of (a) the Russian Admiral Bellingshausen, who bestowed the name *Palmer Land* in or soon after 1821; (b) the British Admiralty, which published the name in 1822; (c) the French government, which published the name in 1824; (d) the United States government, which made the name obligatory in 1912 on all appropriate federal maps, charts and other official publications; (e) the American Geographical Society of New York, which unveiled a bronze plaque

[1] Abstract of a paper read before the American Philosophical Society at Philadelphia, on November 26, 1937. The full paper will appear in the *Proceedings* of the society.

in its house at Broadway and 156th Street in 1914 in commemoration of Captain Palmer's achievement; (f) the National Geographic Society, the Franklin Institute, the American Philosophical Society, and so forth.

The logbook of the *Hero* and associated manuscripts in the Palmer Papers demonstrate three important things. The motive for the voyage was business, namely, the gathering and sale of fur-seal skins and seal-oil. Palmer discovered Deception Harbor, the breached volcanic crater in Deception Island; he explored Yankee Sound [McFarlane Strait] and many other parts of the South Shetland Islands, charting them creditably but not platting his observations into maps. Last but by no means least, the log of the *Hero* specifically demonstrates that various secondary accounts of the adventure are erroneous.

One author, writing only a dozen years after the return of the *Hero,* and writing from Stonington, asserted that Palmer encountered the Russian Admiral on the return from the discovery cruise; obviously he had not perused the log of the *Hero* which proves that the encounter took place some 80 days earlier and in 1820 rather than in 1821. Another author, writing from Philadelphia, said that "only remarks about the weather and the sea are entered [in the log of the *Hero*] during the time in which [Captain Palmer's] exploration was made"; this gentleman did not read the right portion of the logbook; a third author set forth the logbook record of the first one of the seven days of the discovery cruise, and then presented an erroneous digest of the entries for the six ensuing days during which Palmer went to Antarctica and back; if he observed the words that contain the specific latitude of the Antarctic coast and the characterization of its appearance, he did not apprehend their significant importance. And yet this third author wrote a whole book about Captain N. B. Palmer.

Finally it must be pointed out that the Royal Geographical Society's claim, a dozen years ago, that Bransfield anticipated Palmer some nine months in the discovery of the Antarctic mainland, is not based upon any existing logbook, as Palmer's discovery is now known to be. The third-hand record of Bransfield's sighting of a supposed peak, through fog, on January 31 or February 1, 1820, does not necessarily involve a peak on the Antarctic mainland rather than upon one of the islands northeast of the terminus of Palmer Land.

The log of the *Hero* is irrefutable evidence of Captain Palmer's discoveries in November, 1820, near 60° 10′ West Longitude and 63° 45′ South Latitude.

LAWRENCE MARTIN

THE LIBRARY OF CONGRESS

THE WATER CONTENT OF MEDUSAE

THE impression that medusae consist of 99.8 per cent. water appears to have become current among biologists. This idea seemingly originated from Gortner's[1] report that a 500 gram medusa had left less than half a gram dry residue. Gortner's finding was already questioned by Bateman,[2] who quoted some of Krukenberg's[3] data on the matter. Gortner's reply seems to me unconvincing and refers to only one of the several available references on the water content of medusae. The fact that the wet weight of Gortner's medusa was not accurately known is of no consequence since the error in the wet weight would need to be enormous to make a difference of 3 or 4 per cent. in the water content. The method of drying, however—simply leaving the medusa to dry in air on a sheet of paper—is thoroughly objectionable. In recent observations on medusae (*Aurelia*) left to dry on a sheet of paper, I have found that the medusae soon decompose and the jelly liquefies to a thin watery fluid which inevitably runs off the paper, leaving only a fraction of the original animal behind. I believe this is the reason Gortner's medusa left only a trace of dry matter. There is nothing about his report to indicate that the animal was watched during the drying process (which probably required three or four days) to see that no loss occurred. Some sort of error in Gortner's observation is self-evident, as Hill[5] has already pointed out, for a medusa must at least leave a salt residue similar to the salt content of the sea, which for a 500 gram medusa would amount to 16 or more grams, surely something more than a hardly visible stain on a sheet of paper. My oven-dried medusae, half or less the weight of Gortner's animal, dried to a yellowish sheet, containing an abundance of salt crystals.

The following is believed to be a complete list of the literature on the water content of medusae. Krukenberg[3] reported a water content of 95.4 per cent. for *Rhizostoma,* 95.3 and 95.79 per cent. for *Aurelia,* and 95.75 and 96.3 for *Chrysaora.* Vernon[6] gave the content of *Carmarina* as 0.38 per cent. organic matter plus 4.3 per cent. salts and of *Rhizostoma* as 0.53 per cent. organic matter plus 4.3 per cent. salts, or a water content of about 95.3 per cent. Hatai[7] records a water content of 94.14 per cent. for entire *Cassiopea,* 94 per cent. for the umbrellar jelly alone, and 93.8 p

[1] *Trans. Faraday Soc.,* 26: 678; quoted in full SCIENCE, 77: 282.
[2] *Jour. Exp. Biol.,* 9: 124.
[3] *Zool. Anz.,* 3: 306.
[4] SCIENCE, 77: 282.
[5] *Trans. Faraday Soc.,* 26: 687.
[6] *Jour. Physiol.,* 19: 18.
[7] *Carnegie Inst. Wash. Publ.* 251: 97.

t. for the more cellular parts (margin and oral es). Teissier[8] found 96.5 per cent. water in *Chrysra hyposcella.*

The foregoing figures apply to medusae taken in ter of typical salinity or nearly so. In very brackwater, the water content may increase, at least in *relia.* Thus Möbius[9] reported a water content of 9 and 97.94 per cent. for *Aurelia aurita* from the y of Kiel with a salinity of 17–18 parts per thoud. This result has recently been verified by Thill,[10] o found 98 per cent. water in *Aurelias* from a port the Danish Wiek on the Baltic with a salinity of per thousand.

During a stay at the Mt. Desert Island Biological boratory, Maine, the water content of several large *relias* was determined. The salinity of the water und Mt. Desert Island is given by Bigelow[11] as 5–32.6 parts per thousand, a little less than that of open Atlantic. The animals used were pulsating vely but were not anatomically perfect, all showing e marginal damage. It was not thought advisable rinse them in fresh or distilled water because of a sible loss of salts; but No. 7 was thoroughly rinsed fresh water as a check. The others were simply ined for a few minutes. The drained medusae were nediately placed in previously weighed glass or minum containers and subjected to dry heat in an tric oven at temperatures varying from 60 to ° C. The drying was completed in a desiccator r concentrated sulfuric acid.

The data on the nine specimens used are given in ble 1.

TABLE 1

No.	Wet weight grams	Dry weight grams	Per cent. water
1	175.013	7.141	95.9
2	163.892	6.639	96.0
3	82.271	2.831	96.6
4	86.140	3.434	96.0
5	123.745	4.689	96.2
....	129.444	4.915	96.2
....	149.255	5.619	96.3
8	127.802	4.872	96.2
9	264.916	10.382	96.1

From these data and those in the literature it is ent that the water content of medusae in sea-water typical salinity is 94–96.5 per cent.; in brackish er of less than half this salinity, the water content y rise to 98 per cent.

L. H. HYMAN

LABORATORY OF EXPERIMENTAL BIOLOGY
AMERICAN MUSEUM OF NATURAL HISTORY

[8] *Bull. Soc. Zool. France,* 57: 160.
[9] *Zool. Anz.,* 5: 586.
[10] *Zeit. wiss. Zool.,* 150: 51.
[11] *Bull. U. S. Bur. Fish.,* 40, pt. II: 813.

MEDICAL CLASSICS

PROFESSOR J. M. D. OLMSTED, of the University of California Medical School, contributed to the issue of SCIENCE for December 3 a statement concerning the second number of *Medical Classics,* which was published in October, 1936. This number was devoted to four of the important papers of Sir Charles Bell, those illustrating the original work on Bell's Law, Nerve, Palsy and Phenomenon. Dr. Olmsted overlooked three of the contributions of Bell, especially the "Idea of a New Anatomy of the Brain" which is one of the most important and difficult to obtain of any of Bell's writings. Of the five leading medical libraries in the United States only the Army Medical Library owns a copy.

Dr. Olmsted confines his review to a criticism of the use of Bell's paper, "On the Nerves," and states that the paper as published was not as given before the Royal Society on July 12, 1821. Bell's paper, as we reproduced it, was preceded by a photographic reproduction of the title page of the book from which it was taken, "The Nervous System of the Human Body," published in Washington in 1833. I believe no one would be in doubt as to the actual source of the paper.

When we consider that Magendie himself gives Bell credit for priority, I do not believe it adds to our stature to stress small differences in the texts of these two great men. The battle of Magendie *versus* Bell has raged for a hundred years, and even now there appear many advocates for either side. It is the intention of *Medical Classics* to convey knowledge as we find it in these famous papers and not necessarily to attempt to show old rivalries and differences of opinion as to whom proper credit is due. The modern physician, whom we are trying to interest in the broad aspects of medical history, does not like to be confused and irritated by petty controversies. Both Magendie and Bell were great men, and there is honor enough for both of them.

EMERSON CROSBY KELLY

POLLEN AND HAY FEVER

THE letter from Dr. Douglas H. Campbell published in SCIENCE for January 7, page 16, is an interesting example of the reappearance of ideas which at one time might have been regarded as plausible. However, a few minutes' inquiry should be sufficient to relegate this one to the shelf where it has lain undisturbed for some sixty years.

If the medical man of whom Dr. Campbell inquired had been an allergist, he would have referred him either to Dr. Charles Harrison Blackley's "Hay Fever," published by Baillière, Tindall and Cox, London, second

edition, 1880, pages 123 to 125, or to Dr. August A. Thommen's part 3 of "Asthma and Hay Fever in Theory and Practice," Charles C. Thomas, Springfield, 1931, pages 503 to 505. Dr. Campbell's theory is thus merely a repetition of Dr. Wilson's theory published with such confidence in 1873 and dealt with so ably by the pioneer in hay fever pollen research, Dr. Blackley.

A casual inquiry into the present-day methods of the preparation of pollen antigen would disclose the fact that the irritating element is obtainable in equal amounts from perfectly fresh pollen and from that which has been denatured and kept in storage for many years. It is not at all necessary for the pollen granule to touch the mucous membrane to cause the characteristic reaction. Instillation of active extracts of pollen will accomplish the same result with the same rapidity. Moreover, skin tests will show equally strong positive reactions, whether they be made with perfectly fresh pollen, with pollen which has been subjected to desiccation and kept for many years, with pollen which has been washed with ether or with extracts of pollen made by any of a score of methods, all of which would prevent any possibility of development of pollen tubes. Further research along this line would not seem to offer any worth-while possibilities.

O. C. DURHAM

ABBOTT LABORATORIES,
NORTH CHICAGO, ILL.

SPECIAL ARTICLES

THE INFLUENCE OF IODOACETIC ACID ON THE RESPIRATORY METABOLISM OF MAMMALIAN TISSUES[1]

IN 1929, Lundsgaard[2] observed that iodoacetate (IAA) inhibited the glycolytic mechanism, yet permitted muscular contraction to continue, a fundamental observation which caused a revolution in the concept of the chemistry of the contraction process in muscle. This work led to a further exploration of the nature of the IAA effect, with results that have been of considerable significance for the study of carbohydrate metabolism and the lactic acid cycle in muscle as well as in other tissues.

Although Lundsgaard[3] later pointed out that, with proper concentrations of IAA, the respiration of frog muscle and of yeast cells could be maintained at normal levels for some time, little was known of the nature of the foodstuffs oxidized under these conditions until Meyerhof and Boyland's[4] paper appeared, reporting that the R.Q. of such muscles, with 70 per cent. of the original respiration, was about 0.71, indicating virtual cessation of carbohydrate metabolism. When lactate was added to this preparation, respiration was stimulated, and the R.Q. rose to 0.95, showing oxidation of the added lactate. Krebs's[5] studies on the oxygen uptake of brain, testis and sarcoma under the influence of IAA furnished more support to the view that, in addition to inhibiting lactic acid formation, IAA prevented the oxidation of glucose, although it did not interfere with the oxidation of lactate. Quastel and Wheatley[6] also concluded that exposure of brain tissue to IAA rendered it unable to utilize glucose. These results have had a considerable influence in shaping the theories of the pathway of glucose oxidation in the cell, as well as on the interpretation of the mechanism generally known as the Pasteur-Meyerhof reaction. They would suggest that glucose or preformed carbohydrate may have to go through a lactic acid stage before it can be oxidized. They may also be interpreted as favoring the unitary theory of oxidation and fermentation which postulates a common initial aerobic and anaerobic pathway of carbohydrate degradation. When this pathway is interrupted by IAA, and no endogenous lactate is available for oxidation and resynthesis, oxidation of carbohydrate ceases. Finally, an inhibiting effect of IAA on the phosphorylation mechanism has been demonstrated by Lohmann.[7]

However, Stannard[8] and Saslow[9] have recently reported that non-nutrient R.Q.'s of normal and caffeinized frog muscle lay between 0.90 and 1.00, even though anaerobic glycolysis had been stopped by treatment with IAA and iodoacetamide. We have extended the investigation of the nature of the oxidative process in IAA poisoning to mammalian tissues, using skeletal, smooth and cardiac muscle, as well as brain, from normal cats and dogs. The brain cortex, freed as much as possible of white matter, was minced. The cardiac muscle was cut into thin slices. Smooth muscle was obtained from the small intestine by a method (unpublished) developed by Eugene Cohen in this laboratory. The skeletal muscle was prepared by careful dissection of bundles of muscle fibers sufficiently thin for micro-respiration studies. Prior to study in the Warburg apparatus, the tissues were aerated in Ringer solution to permit the loss by diffusion of any lactate which

[1] From the New York Hospital and the Departments of Medicine and Physiology of the Cornell University Medical College, New York City. Supported in part by a grant from the Committee on Research in Endocrinology of the National Research Council.

[2] E. Lundsgaard, *Biochem. Zeit.*, 217: 162, 1930.

[3] E. Lundsgaard, *Biochem. Zeit.*, 220: 8, 1930.

[4] O. Meyerhof and E. Boyland, *Biochem. Zeit.*, 237: 406, 1931.

[5] H. A. Krebs, *Biochem. Zeit.*, 234: 278, 1931.

[6] J. H. Quastel and A. H. M. Wheatley, *Biochem. Jour.*, 26: 725, 1932.

[7] K. Lohmann, *Biochem. Zeit.*, 236: 444, 1931.

[8] J. N. Stannard, *Amer. Jour. Physiol.*, 119: 408, 1937.

[9] G. Saslow, *Jour. Cell. Comp. Physiol.*, 10: 385, 1937.

ght have accumulated during their preparation. emical estimations were made of the lactic acid content of the tissues and medium at the beginning and d of the experiments to determine whether this subnce could have served as a substrate. The respiray measurements were made in Ringer-phosphate lution of pH 7.4, to which glucose and IAA were ded as desired. Glycolysis was measured manotrically and chemically in Ringer-bicarbonate solus exposed to an atmosphere of 95 per cent. nitro-n-5 per cent. carbon dioxide. Concentrations of utralized IAA were chosen which abolished all but inimal amounts of glycolysis, yet allowed a satisfacry maintenance of respiration. The results of typl experiments have been assembled in Table 1.

To judge from the R.Q.'s obtained with brain and l three types of mammalian muscle, oxidation of car-

TABLE 1

Tissue	Respiratory Quotient				Oxygen Consumption				Inhibition of Glycolysis	Concentration IAA
	Non-nutrient	N.N. IAA	Glucose 0.2 per cent.	Glucose IAA	Non-nutrient	N.N. IAA	Glucose 0.2 per cent.	Glucose IAA		
							cu mm/moist mg/hr.		per cent.	
keletal	0.86	0.89			0.31	0.21			94*	1/10,000
muscle (dog)	0.94		1.03	0.97	0.26		0.26	0.17	98*	1/10,000
mooth	0.85		0.95	0.95	0.30		0.34	0.26	90†	1/10,000
muscle (cat)	0.95		1.05	1.01	0.25		0.24	0.23	94†	1/10,000
eart (cat)	0.87		0.96	0.99	0.33		0.37	0.37	90*	1/100,000
eart (dog)	0.83	0.81	0.91	0.90	0.60	0.58	0.61	0.58	99*	1/75,000
rain gray	0.97	0.98	0.97	1.12	0.42	0.35	0.66	0.44	97*	1/100,000
matter (cat)	1.06	1.09	1.02	0.96	0.34	0.30	0.61	0.47	94*	1/100,000

* Lactic acid determined chemically. † Lactic acid estimated manometrically.

hydrate appears to take place as readily in the esence of sufficient IAA to inhibit glycolysis as in absence. Furthermore, not only is preformed carhydrate oxidized under these conditions, but added cose is as effective in elevating the R.Q. in the sence of IAA as in the controls. Chemical analyses wed that preformed lactate was not responsible for e elevated quotients.

These results are in accord with those of Stannard d of Saslow on frog muscle. The disagreement ween our results and those of Meyerhof and Boyd, of Krebs and of Quastel and Wheatley may be to the greater concentrations which these other estigators employed. It may well be that toxic cts were produced by the higher concentrations te apart from the specific influence of the poison on metabolism. Furthermore, Krebs and Quastel and eatley depended entirely on measurements of gen consumption to judge of inhibition of carborate oxidation. The effect of lactate on respiration d the R.Q. of IAA poisoned tissue, pointed out by early workers, can readily be confirmed, but much the significance of this observation would be lost in view of the persistence of the capacity to burn glucose under the same conditions.

Our experiments lend no particular support either to the theory that carbohydrate must go through a lactic stage before it can be oxidized, or to the unitary theory of oxidation and fermentation. Carbohydrate oxidation, at least under these conditions, appears to be independent of the anaerobic mechanism. Nor does IAA specifically affect the phosphorylating process, if esterification is a necessary preliminary to glucose oxidation. The mechanism of the specific action of IAA on intermediary carbohydrate metabolism warrants further investigation in the light of these findings.

E. Shorr
S. B. Barker
M. Malam

CRYSTALLINE FACTOR I

Of the five known components of the vitamin B complex, three of them—thiamine, riboflavin and nicotinic acid—have been available in crystalline form. The other two,[1] factor 1 and factor 2, have so far been known as extracts. Factor 1 has now been crystallized by a procedure to be described elsewhere. The crystals are colorless rods which aggregate mostly as rosettes and sometimes in fan shapes. The dry crystalline material has a very slight yellowish tinge which is probably due to a slight amount of impurity. Dermatitis of the peripheral parts of the body of rats on factor 1-deficiency diets[1] involving the feet, paws, ears and areas around the mouth[2] is promptly cured with a daily dose of 10 micrograms of crystalline factor 1; 5 micrograms daily will clear up the dermatitis somewhat more slowly. Rats on factor 1-free diets, in which growth had ceased, responded immediately with gains in weight on administration of crystalline fac-

[1] S. Lepkovsky, T. H. Jukes and M. E. Krause, *Jour. Biol. Chem.*, 115, 557, 1936.

[2] T. W. Birch, P. György and L. J. Harris, *Biochem. Jour.*, 19, 2830, 1935.

tor 1. The potency of this preparation of factor 1 as measured by such gains in weight is given in Table I.

TABLE I

WEIGHT INCREASE OF RATS FED CRYSTALLINE FACTOR 1 FOR 14 DAYS

Daily intake of factor 1 Micrograms	Average daily gain in weight Grams
25.0	3.4
20.0	3.4
10.0	3.4
5.0	2.5
2.5	2.4

An independent check of the potency of crystalline factor 1 was made by Mrs. M. K. Dimick at the Biological Laboratory of the Vitab Products, Inc., with similar results. In this experiment, rats which had ceased to grow on the factor 1-deficient diet,[1] gained an average of 3 grams daily when fed 10 micrograms of crystalline factor 1 daily; and when 5 micrograms were fed daily, the rats made an average daily gain of 2 grams. The factor 1-deficient diets were similar in composition,[1] the only difference being in the factor 2 concentrate, a liver filtrate being used by Mrs. Dimick, and a rice bran filtrate, in the laboratory of the Poultry Division.

This work was greatly facilitated by a financial grant from Eli Lilly and Co.; by crude factor 1 concentrates made for us by Eli Lilly and Co., and the Vitab Products, Inc.; and by materials and personnel from the WPA (project No. 8261).

SAMUEL LEPKOVSKY

POULTRY DIVISION,
UNIVERSITY OF CALIFORNIA

ANEURIN AND THE ROOTING OF CUTTINGS[1]

WITH the increase of our knowledge concerning the principles of plant growth and development, it has been possible to solve some interesting practical problems by a purely scientific approach. Thus the discoveries, in rapid succession, of the growth hormone (auxin), of its chemical nature, of the identity of the growth hormone with one of the hormones of root formation and of the growth hormone activity of indole derivatives have led to a number of practical applications, particularly in the rooting of cuttings.[2] It soon became clear, however, that root initiation and subsequent root growth are conditioned by a complex set of factors of which auxin, although of great importance, is but one. Sugar and biotin were soon recognized as additional factors in root formation (Went and Thimann[3]). An independent line of research has led to the recognition of aneurin (vitamin B_1) as a hormone of root growth.[4] Under normal conditions the extremely small amounts of aneurin which are required for root growth (as judged by the amounts required by roots *in vitro*) are supplied by other parts of the plant. Without aneurin, or derivatives of it, no root growth is possible. This consideration has led us to expect that under certain conditions aneurin should be the limiting factor for root development on cuttings. That this is actually the case is shown by the following experiments: etiolated pea stems were treated basally for ca 20 hours with indole acetic acid (20–200 mgs per liter), and were then transferred to bottles containing 5 cc of 2 per cent. sucrose solution. At different times after the auxin treatment, aneurin, over a wide range of concentrations, was added to the sugar solutions for different periods of time. With the exception of the highest concentrations (100–20 mgs per liter) applied soon after the auxin treatment, all the aneurin treatments caused a marked increase in the number and size of the visible roots. Concentrations of 1 mg per liter or lower, applied 5 to 9 days after the auxin treatment, gave the most vigorous response, which amounted to several hundred per cent. more visible roots than in the non-aneurin treated controls. Histological investigations show that 5 days after the above auxin treatment large numbers of root primordia have been formed. The number of these primordia which grow out is, as shown by the above experiments, limited by the available aneurin. That it is not root initiation which is primarily affected by aneurin is shown by the fact that aneurin without previous auxin treatment is without influence upon the root formation of these cuttings.

A number of other experiments were carried out under practical nursery conditions. Leafy lemon cuttings were treated overnight with indole acetic acid (200 mgs per liter) and were then allowed to stand for one week in sand in a propagating frame. The bases of these cuttings were then placed for 24 hours either in water or in an aneurin solution (1 mg per liter). Thirteen days later the control cuttings, after-treated with water, had 8.1 roots apiece, while the aneurin-treated plants had 16.3 roots each. These roots were in addition much longer than those of the water after-treated cuttings. The controls which were not treated with indole acetic acid had only 0.3 roots per cutting. Still more striking was an experiment with leafy Camellia cuttings, which are notably slow in rooting. After repeated indole acetic acid treatment (200 mgs per liter for 20 hours each time), 30 out of 200 cuttings

[1] Report of work carried out under the auspices of the Works Progress Administration, Official Project Number 165-03-6999, Work Project Number 6330-6989.

[2] These discoveries are sometimes erroneously attributed to the investigators of the Boyce Thompson Institute.

[3] F. W. Went and K. V. Thimann, "Phytohormones," New York, 1937.

[4] J. Bonner, SCIENCE, 85: 183, 1937; W. Robbins and M. Bartley, SCIENCE, 85: 246, 1937.

had still failed to root. Twelve of these were then treated with water, another 12 with aneurin (1 mg per liter) for 24 hours. One week later a total of three short and poor roots had developed on the water-treated set. Those treated with aneurin, on the other hand, all rooted vigorously and formed a total of 67 sizable roots.

It is also known that certain "essential" amino acids exert a beneficial effect upon the growth of some roots.[5] It can therefore be predicted that cuttings may be found in which root development is limited by these substances.

The above experiments are a logical outcome of the series of discoveries concerning the plant growth hormones. They demonstrate clearly that aneurin, the root growth hormone, if it is applied at the appropriate time after roots have been initiated by auxin, greatly increases the root development of cuttings, and may hence become as important in nursery practice as are the auxins themselves.

F. W. Went
James Bonner
G. C Warner

William G. Kerckhoff Laboratories
of the Biological Sciences,
California Institute of Technology

SCIENTIFIC APPARATUS AND LABORATORY METHODS

QUANTITY COLLECTING OF PLANKTONIC DIATOMS[1]

In the contribution to Science of December 4, 1937, by Dr. G. L. Clarke concerning the collecting of marine plankton diatoms I notice several surprising assertions which were not entirely acceptable on available evidence. Perhaps a word of dissent is in order. For the sake of brevity only brief reference to particular items will be attempted.

1. Small size of plankton diatoms is not always (if ever) detrimental to collecting them. Bigelow,[2] Trask[3] and other American and European observers have commented on the ease of obtaining large quantities at particular times and places.

2. It is not always necessary to "strain very large volumes of water." For example, in the 12,000,000 cells per liter population found by Trask near Grays Harbor, Washington, thirty liters would have yielded a large quantity. This could have been obtained with far less trouble by dipping and "straining" that amount than would be involved in operation of "six tow nets" at once.

3. It seems to be assumed that if diatoms are taken from sea water all specimens are uniformly representative in chemical composition. This assumption is not tenable. At the Scripps Institution of Oceanography it has been found that some larger population near the surface of the sea show nearly 50 per cent. in decadent condition.[4] There are other reasons why the physical or the functional conditions of a particular population should be noted before it is assumed to be representative, although chemical analysis of a number of populations may offset this deficiency in general observation for certain purposes.

4. It is true that "purity of the catch" is requisite for reliable "chemical analysis," but *that* is a common characteristic of plankton diatom populations showing excessive abundance, *i.e.*, above a million cells per liter. In a population as low as 200,000 cells per liter considerable numbers of several other kinds of organisms may be encountered. Some of these have dimensions similar to those of the diatoms and would not be excluded by the ingenious reversed cone device. For full satisfaction concerning "purity" a dense population should be found in which natural exclusion of other organisms is practically complete.

5. As a general statement, the assertion that 200,000 cells per liter "approaches the maximum richness observed for diatom flowerings" is not acceptable. In addition to the reports from European and other North Atlantic waters, there are a number of instances in which millions of cells per liter have been found in Pacific waters from the Gulf of Panama to the region of Juneau, Alaska.[5] The Gulf of Santa Catalina is not one of the most productive regions, but at the Scripps Institution of Oceanography in certain years whole weeks (mss. records) have been noticed in which the abundance remained above a million cells per liter in daily catches.

W. E. Allen

Scripps Institution of Oceanography,
La Jolla, Calif.

THE PREPARATION OF ABSOLUTE ETHER

"The customary method of preparing absolute ether consists in shaking the ether repeatedly with water to remove alcohol and finally drying with sodium."[1] The

[5] P. White, *Plant Physiol.*, 12: 793, 1937; J. Bonner and F. Addicott, *Bot. Gaz.*, 99: 144, 1937.

[1] Contributions from the Scripps Institution of Oceanography. New Series, No. 12.

[2] H. B. Bigelow, U. S. Bur. Fish. Doc. No. 968, 1926.

[3] P. D. Trask, "Origin and Environment of Source Sediments of Petroleum," Gulf Publishing Company, 1932.

[4] W. E. Allen, *Quart. Rev. Biol.*, 9: 170, 1934.

[5] W. E. Allen, *Bull. Scripps Inst. Oceanog.*, 1: 42, Univ. Calif. Press, Berkeley, 1927; W. E. Allen, Science, 70: 418, 1929; E. E. Cupp, *Trans. Am. Micros. Soc.*, 53: 25, 1934.

[1] D. W. McArdle, "Solvents in Organic Chemistry," Van Nostrand, New York, p. 83, 1927.

labor required for the preparation, as well as the loss of ether, is much reduced by the following procedure.

To 3 l. of U.S.P. ether is added 450 g. of technical flake sodium hydroxide, and the mixture is allowed to stand at room temperature (25–30°) for two weeks with occasional shaking. After the first day the liquid becomes yellow and the sodium hydroxide appears somewhat powdery. After a week the color has nearly disappeared from the ether, but the sodium hydroxide has become yellow or brown. In about two weeks the ether is colorless and may be used directly for most purposes which require absolute ether, such as Grignard reactions. Since the non-volatile residue is very small (5 cc of the ether thus prepared left <0.01 mg of residue dried at 40°, or $<0.0_{3}2\%$), distillation can ordinarily be omitted. The ether can be decanted and stored over sodium with very slight evolution of hydrogen.

The sodium hydroxide can not profitably be used for a second lot of ether without purification. Smaller proportions of hydroxide to ether result in lengthened time and eventually incomplete decolorization. Other processes using sodium or potassium hydroxide for drying ether are described in patents (Hammond, U. S. 1,466,435 and 1,466,436 (1923) and others). The ether is best stored over a small amount of sodium in bottles at least three quarters full to minimize "breathing" with change in temperature. Under these conditions, no peroxide formation has been observed. The cost of absolute ether made by this method is much less than the current price, and the quality, judged by its behavior both toward sodium and toward dilute permanganate in strongly alkaline solution,[2] is better than that of commercial grades.

W. F. BRUCE

BAKER LABORATORY
CORNELL UNIVERSITY

THE USE OF CARBON DIOXIDE IN THE PREPARATION OF SILICIC ACID JELLIES

IN studies on the growth of hydrogen-oxidizing bacteria on silicic acid jellies certain difficulties in the preparation of the jellies have been overcome by neutralizing the silicate with carbon dioxide. To 16 ml of nutrient solution in 6- or 12-oz. glass bottles is added 2 ml of a potassium silicate solution which has been made normal with respect to titrable alkalinity. A sufficient quantity of a mixture of normal hydrochloric, phosphoric and sulfuric acids is then added to give a reaction of approximately pH 8.0. After the bottles containing this liquid medium have been evacuated to a pressure of about 7.5 cm of mercury, a gas mixture consisting of 60 per cent. hydrogen, 20 per cent. oxygen and 20 per cent. carbon dioxide is run in to equalize the atmospheric pressure. The bottles are placed in a horizontal position, and within twenty or thirty minutes the carbon dioxide has been absorbed and the silicate has set to a firm transparent medium with a reaction of approximately pH 7.0.

HAROLD W. BATCHELOR

OHIO AGRICULTURAL EXPERIMENT
STATION, WOOSTER

P. W. WILSON

FRASH BIOCHEMICAL LABORATORY,
UNIVERSITY OF WISCONSIN

[2] G. S. Forbes and A. S. Coolidge, *Jour. Am. Chem. Soc.*, 41: 152, 1919. Commercial U. S. P. ether, absolute ether and the product above gave the following reaction times: 3, 12 and 20 seconds, respectively.

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